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CARPINTERIA SALT MARSH

ENVIRONMENT, HISTORY, AND BOTANICAL RESOURCES OF A SOUTHERN CALIFORNIA ESTUARY

Wayne R. Ferren, Jr.



The Herbarium
Department of Biological Sciences
University of California, Santa Barbara
Publication Number 4
1985

Cover: Left top and bottom — *Cordylanthus maritimus* Nutt. ex Benth. in DC. ssp. *maritimus* [Salt Marsh Bird's-Beak] is a member of the Figwort Family and reaches its northwestern limit of distribution at Carpinteria Salt Marsh, where it is uncommon but locally abundant in high marsh habitat. This species is listed as endangered by the U.S. Fish and Wildlife Service. Right top and bottom — *Lasthenia glabrata* Lindl. ssp. *coulteri* (Gray) Ornduff [Salt Marsh Daisy] is a member of the Aster Family and occurs in salt marshes, some vernal pools, and other generally saline habitats from San Diego to Kern Counties. Like Salt Marsh Bird's-Beak, it was once more common than it is today. Destruction of sensitive wetland habitats has resulted in a significant loss of populations of both taxa.

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F O R E W O R D

Manuscripts accepted for presentation in the Publication Series of the Herbarium, Department of Biological Sciences, University of California, Santa Barbara, include primarily those with a floristic emphasis and those for which voucher specimens are deposited at UCSB. This endeavor is consistent with the goals of the UCSB Herbarium, summarized as follows: 1) to maintain a botanical collections repository; 2) to provide educational programs; 3) to provide botanical services; 4) to function as a research facility within the Department of Biological Sciences.

UCSB Herbarium Publication Number 4, Carpinteria Salt Marsh: Environment, History, and Botanical Resources of a Southern California Estuary, is a product of research conducted by a herbarium staff member with the assistance of many UCSB students, faculty, and staff. The study was conducted intermittently over a period of seven years and was funded by various sources, including the UC Natural Reserve System, the UCSB Herbarium, and the County of Santa Barbara in association with the California Coastal Conservancy. Although funding for manuscript preparation and publication was provided in part by these sources, the majority of the funds were acquired by the UCSB Herbarium from additional extramural sources.

A portion of the study area investigated during this project is known as Carpinteria Salt Marsh Reserve, property managed by the University of California, Santa Barbara, as part of the University of California's Natural Reserve System (NRS). This system includes 26 reserves dispersed broadly through the state, providing a selected variety of ecosystems in support of academic programs of higher education. The NRS publishes materials about the reserves periodically, and this publication is NRS Contribution No. 13.

Wayne R. Ferren, Jr.

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INTRODUCTION



BACKGROUND

PURPOSE

METHODS

INTRODUCTION

Background - Estuaries are complexes of deepwater habitats and/or wetlands that are transitional between the aquatic habitats of otherwise terrestrial environments and the marine habitats of oceans or seas. They are generally basins at the lower elevational limits of watersheds, and thus receive freshwater runoff from the inlands, at least seasonally, and are open at their mouths to the marine environment at least part of the year. Estuaries of North America have been formed by several processes and include the following examples: mouths of rivers, streams, or glacial valleys that often form extensive bays along submergent coastlines; incised river canyons and structural basins along generally emergent coastlines; lagoons landward of barrier islands or sandspits; and similar coastal embayments where a mixing of freshwater and ocean-derived salt water occur. Major physical factors affecting estuaries include oceanic tidal circulation, precipitation, freshwater runoff, evaporation, and wind (Cowardin et al., 1979). Salinity regimes may fluctuate considerably in some estuaries, and are influenced by the amount and seasonality of rainfall, runoff amounts from their watersheds, and the evaporation of standing water when estuary mouths are closed by sandbars (Zedler, 1982).

Although they receive water, detritus, nutrients, sediment, salts, and man-made contaminants from surrounding environments, estuaries are discrete ecosystems that are encompassed by other natural and man-made environments. For example, estuarine wetlands are usually adjacent to and/or downstream from freshwater intertidal and/or nontidal wetlands, are at least seasonally contiguous to marine wetlands, and are nearly surrounded by upland habitats. These uplands occur over a broad range of latitudes; and thus are influenced by different climatic conditions, such as varying amounts of rainfall and solar radiation. Furthermore, regional differences of coastal submergence or emergence in turn affect rates of watershed erosion and subsequent sedimentation in the basins.

Because of the relative degree of isolation among wetlands of different estuaries and the varying factors of the physical environment that influence these wetlands, estuaries can be considered similar to oceanic islands--each has a unique combination of environmental parameters and is separated from other estuaries by some form of physical and biological barrier. While these barriers may not be of great significance to many organisms (e.g., migratory birds), they appear to be effective in limiting dispersal for some vascular plants, as illustrated by the endemism that characterizes estuaries and adjacent freshwater intertidal zones in northeastern North America (Fassett, 1928; Ferren, 1976; Ferren and Schuyler, 1980). However, estuarine wetlands in general are dominated by relatively few vascular plants, many of which are widespread succulent species that tolerate the saline and tidal conditions characteristic of estuaries (Zedler, 1982).

Along the Pacific coast of the contiguous United States, estuaries are scattered over approximately 1180 miles (1900 km) of coastline from the Tijuana Estuary near the border of San Diego County, California, and Baja California Norte, Mexico, northward to the extensive estuarine system occurring between the State of Washington and British Columbia, Canada. The more northern estuaries of this large region are similar to those of eastern North America because they are located in a climatic zone that has sufficient precipitation to provide enough freshwater runoff to influence salinity regimes, mouth closure, composition of vegetation, and other physical and biological aspects of estuaries. In contrast are the estuaries of southern California, typically those south of Point Conception, Santa Barbara County, that occur in a semi-arid Mediterranean climatic zone. North of Point Conception exists a moister Mediterranean climatic zone in central California. Most of the annual precipitation of southern California occurs in a few large winter storms. Under these conditions, physical factors of the estuarine environment are more fluctuating in nature. During the dry summer there are potentially higher salinities in areas of evaporation and higher soil temperatures, and a lack of tidal circulation should the mouth of an estuary close. During the winter, occasional seasonal storms can flood the estuary with large amounts of freshwater runoff containing

thousands of tons of sediment. Such catastrophic events have been found to alter significantly the biological resources of estuaries (e.g., Lohmar et al., 1980; Zedler, 1982, and in press).

Carpinteria Salt Marsh is an estuary located in Santa Barbara County, California, and thus is near the northern coastal limit of the southern California as defined by Munz (1974). General interest in the botanical resources of the wetlands has resulted in at least a mention of the estuary in many scientific publications on coastal wetlands (e.g., Henrickson, 1976; Macdonald, 1977; Zedler, 1982) and in public documents (e.g., County of Santa Barbara, 1979, 1980; City of Carpinteria, 1980). Furthermore, particular interest in Carpinteria Salt Marsh led to a summary of its natural resources by Macdonald (1976). Although Macdonald provided an important evaluation of the estuary that was significant in assisting with the subsequent recognition of the value of this wetland complex and eventual preservation of it, a detailed evaluation of its natural resources has not been available. This is not unusual in southern California, because only recently has research been focused on coastal wetlands of the area.

The proximity of Carpinteria Salt Marsh to the University of California, Santa Barbara (UCSB), the preliminary studies conducted at the site, and the inclusion of a portion of it into the University of California Natural Reserve System (NRS), provided an excellent opportunity for conducting an inventory and evaluation of the botanical resources of the estuary. Furthermore, detailed information available for aspects of the physical environment and the history of the Carpinteria Valley enhanced the possibility of describing these botanical resources in the context of their environmental setting, including the changes that have occurred geologically and historically. Perhaps even more important was the potential for applying this combined information to management goals for Carpinteria Salt Marsh, and in particular, proposals for flood control and marsh enhancement that could have profound effects on the future of these estuarine wetlands.

Purpose - The initial assessment of the botanical resources of Carpinteria Salt Marsh and Reserve evolved over a period of several years to include aspects of the physical environment and history of the Carpinteria Valley, as well as the effects of natural and man-made impacts on the estuarine wetlands. Furthermore, as projects have been proposed that have potential impacts on the estuary, these botanical data have been utilized to assist with the management of Carpinteria Salt Marsh in the future. Thus, as reported herein, this study of Carpinteria Salt Marsh has had three major purposes:

1. To conduct an inventory and evaluation of the botanical resources of a southern California estuary in the context of its physical environment and history. Carpinteria Salt Marsh provides an excellent opportunity to conduct an inventory of the current botanical resources and to evaluate changes in the flora and vegetation over time. Such a study is possible because of the accessibility of the site, the historical collections that are available, and the nearly 60 years of aerial photographs that exist for Carpinteria Valley. Additional environmental and historical data recorded from the region also permit the possible correlation of botanical resources with specific physical phenomena such as the climate and geology of the region, origin and evolution of the estuary, and characteristics of drainage, soils, and land use of the watershed. Thus baseline data and interpretation thereof may demonstrate the significance of Carpinteria Salt Marsh for botanical resources in southern California.

2. To expand the environmental, historical, and botanical resource data base for the Carpinteria Salt Marsh Reserve. The University of California Natural Reserve System, formerly the Natural Land and Water Reserve System, was established 20 years ago to manage examples of native California habitats in a manner that preserves, insofar as possible, the natural ecological processes and the existing biota so that they may be studied with a minimum of human disturbance. The system has grown from 7 sites incorporated at the beginning to 26 reserves, with several new acquisitions pending. Together the reserves contain more than 85,000 acres of land, 20% of which The Regents of the

University of California own, while the remaining property has been made available through conservation easements, leases, or use agreements. Of the 178 major California habitat types identified by Cheatham and Haller (1975) the 26 NRS reserves contain 106 types.

The NRS is part of the UC Division of Agriculture and Natural Resources. Each reserve under its jurisdiction is assigned to one of the 8 general UC campuses for day to day administration. For Carpinteria Salt Marsh Reserve, UCSB assumes the administrative role and a campus NRS Advisory Committee assists the reserve manager with developing guidelines for reserve use and maintenance. The reserve manager is responsible for on-site administration and maintenance.

This botanical resource study was conducted in part to expand the data base available for Carpinteria Salt Marsh Reserve, a portion of but not the entire estuary of Carpinteria Salt Marsh; and, additionally, to stimulate research by identifying interesting phenomena, the study of which would provide potentially valuable knowledge concerning environmental processes in southern California estuaries. Managers responsible for habitats adjacent to the formalized reserve may also find this document useful.

3. To provide pre-project monitoring of botanical resources for the El Estero Improvement and Marsh Enhancement Projects. As part of the permit for conducting flood control work in coastal wetlands, various mitigation measures (e.g., the Marsh Enhancement Project) were designed to offset the negative impacts created by the project and to maximize the positive aspects. Pre-project and post-project monitoring of the vegetation were required as a method to evaluate the occurrence and condition of botanical resources before the El Estero Improvement Plan was implemented and to monitor the revegetation of habitats disturbed or created as a result of this project. The vegetation map and annotated catalogue provided herein are a contribution to the pre-project monitoring, and the vegetation transects (see Botanical Resources: Disturbance and Vegetation Change) and discussion of the project (see The Future: Carpinteria Valley Watershed and Marsh

Enhancement Projects) provide further analysis of the botanical resources and project proposals. Additional results of pre-project monitoring are reported in Onuf (1984a,b,c).

Methods - The botanical resource evaluation of Carpinteria Salt Marsh and Reserve was initiated during July, 1978, with a trip to the estuary conducted by the UCSB Botanical Society. This Society is a student organization advised by the author. Preliminary funding of the project was provided by the UCSB Herbarium and in 1979 by a grant from the NRS to fund the illustration of selected vascular plants that would appear in an annotated catalogue of the species. Subsequent studies were funded by the UCSB Herbarium in the form of extramural funds, by grants from the Santa Barbara County Flood Control and Water Conservation District in association with the California State Coastal Conservancy, and by the NRS.

The vegetation of Carpinteria Salt Marsh was mapped from an aerial photograph (Pacific Western Aerial Surveys PW12794-8, 12-22-81) provided by the Santa Barbara County Flood Control and Water Conservation District. Plant associations were identified during field work conducted throughout the study area. The vegetation was classified as wetland types according to Cowardin et al. (1979) and as upland types according to Cheatham and Haller (1975). Eleven transects were established across berms and along which elevations and species presence and abundance were recorded. From these data, profiles were constructed to illustrate the aspect of berm vegetation and to demonstrate the natural revegetation of disturbed coastal habitats. Selected profiles were chosen for illustration herein.

The vascular plant inventory was conducted periodically over a seven year period during which numerous trips were made to the site on a seasonal and yearly basis. Various habitats that support different plant associations were examined to record changes in the flora and vegetation over time and in an attempt to locate the known historic flora. Seasonal or annual differences in weather patterns can result in an apparent lack of some species, particularly annuals, during periods

unfavorable for plant germination, establishment, and growth. Repeated visits to sites were particularly helpful in high marsh areas that are important for uncommon native annuals during periods of decreased soil salinity. Vouchers for all species were collected, deposited in the UCSB Herbarium, and cited in the catalogue. Historic collections were located in various herbaria (e.g., UCSB, UC, UCLA, CAS, DS, SBBG, SBM, RSA, and POM) to determine the following: 1) whether or not any native species have been extirpated from the estuarine wetlands and surrounding uplands, 2) the historic range of estuarine species in Carpinteria Valley, and 3) the history of botanical exploration of Carpinteria Salt Marsh. Botanical literature (e.g., C. Smith, 1952, 1976; Chuang and Heckard, 1973; Munz, 1974) also was reviewed for records of salt marsh species from the area and for other information relevant to the resources.

During the process of botanical resource inventory and evaluation, data were compiled, largely from published sources, on selected environmental parameters affecting Carpinteria Salt Marsh. These factors included the following: temperature, rainfall, and other climatic factors of the region (Weather Bureau, 1930, 1952; Environmental Data Service, 1973, 1974-1983); watershed, drainage, and soil characteristics (Upson, 1951; California Division of Soil Conservation, 1967a-c; Macdonald, 1976; Shipman, 1981; USDA Soil Conservation Service, 1983); and water quality (Page, 1979; Stanley and Scholin, 1984; Onuf, 1984 a-c; County of Santa Barbara, 1985). Information on the geologic setting and origin of the estuary (Chaney and Mason 1934; Upson, 1951; Dibblee, 1966; Jackson, 1980; Jackson and Yeats, 1982) was reviewed to determine the relationship between the development of estuarine habitats and the extent, occurrence, and diversity of botanical resources.

Prehistoric and historic natural and man-made alterations of the estuary also were investigated to provide insight into the nature of impacts that have affected Carpinteria Salt Marsh and that have often resulted in significant changes in the botanical resources. Aerial photographs obtained from the UCSB Map and Imagery Collections, the Santa Barbara County Flood Control and Water Conservation District,

the Santa Barbara Museum of Natural History, and the Carpinteria Valley Museum of History aided in the interpretation of about 60 years of change in the Carpinteria Valley. Literature (e.g., Stockton, 1960; Penfield, 1960; Clark 1962; Spaulding, 1962; and Caldwell, 1982) aided in a detailed accounting of the gradual alteration of portions of the estuary during the growth of the City of Carpinteria. Prior to the dramatic changes, associated largely with urbanization, that have taken place in Carpinteria Valley, lengthy prehistoric and early historic periods occurred. Literature concerning these periods (e.g., Rogers, 1929; Wilcoxon, 1982) was reviewed for information on the probable extent of the estuary and early use of estuarine resources by native Americans.

The various field and published data gathered during this study also were evaluated in the context of previous botanical resource studies on estuaries of southern California (e.g., Vogl, 1966; Henrickson, 1976; Macdonald, 1977), ecological studies synthesizing estuarine processes (e.g., Macdonald 1976; Lohmar et al., 1980; Zedler, 1977, 1982), and management techniques and proposals (e.g., Zedler, 1982; USDA Soil Conservation Service, 1983; California State Coastal Conservancy, 1983). Thus, the Carpinteria Salt Marsh study has developed over a period of 7 years as an attempt to provide a detailed environmental context for interpreting the results of the botanical resource inventory.

PHYSICAL ENVIRONMENT



LOCATION

CLIMATE

GEOLOGY

DRAINAGE

SOILS

PHYSICAL ENVIRONMENT

Location - Carpinteria Salt Marsh covers about 230 acres (93.1 hectares) and is located at latitude 34° 24' N and longitude 119° 31' 30" W, about 12 miles (19.4 km) east of Santa Barbara and immediately west of the City of Carpinteria, along the South Coast of Santa Barbara County, California (Fig. 1). Otherwise known as Carpinteria Marsh, Carpinteria Slough, El Estero, El Estero de la Carpinteria, and Sandyland Cove, this estuary is presently restricted to a relatively small series of tidal channels and emergent wetlands that occur at the mouths of Franklin and Santa Monica Creeks (Figs. 2 & 3). These streams are among several that drain a portion of the southern slope of the Santa Ynez Mountains (the westernmost ridge of the Transverse Ranges) and the Carpinteria Valley. The latter is part of the coastal plain of Santa Barbara County, and is bounded on the north by foothills of the Santa Ynez Mountains, on the south by the Pacific Ocean, on the east by Rincon Mountain, and on the west by Toro Canyon. The Santa Ynez Mountains north of the Valley reach a height of about 3900 feet (1189 m).

Climate - The Carpinteria Valley is characterized by a Mediterranean climate with mild, moist winters and moderately warm, generally rainless summers. Point Conception, approximately 56 miles (90.1 km) west of Carpinteria Salt Marsh, has been considered as a major climatic boundary in the region (Barbour et al., 1975), separating the relatively cool and moist conditions to the north from the warmer and drier conditions to the east and south. Thus, Carpinteria Salt Marsh is located in the northwestern portion of the southern California Mediterranean climatic region.

This climate is influenced directly by the prevailing westerly transoceanic air currents. However, during winter months the regional trend is for night and early morning offshore air movement driven by continental cooling. By afternoon the prevailing westerly winds and interior convection give rise to regional onshore winds, or occasionally

Fig. 1. LOCATION OF CARPINTERIA SALT MARSH

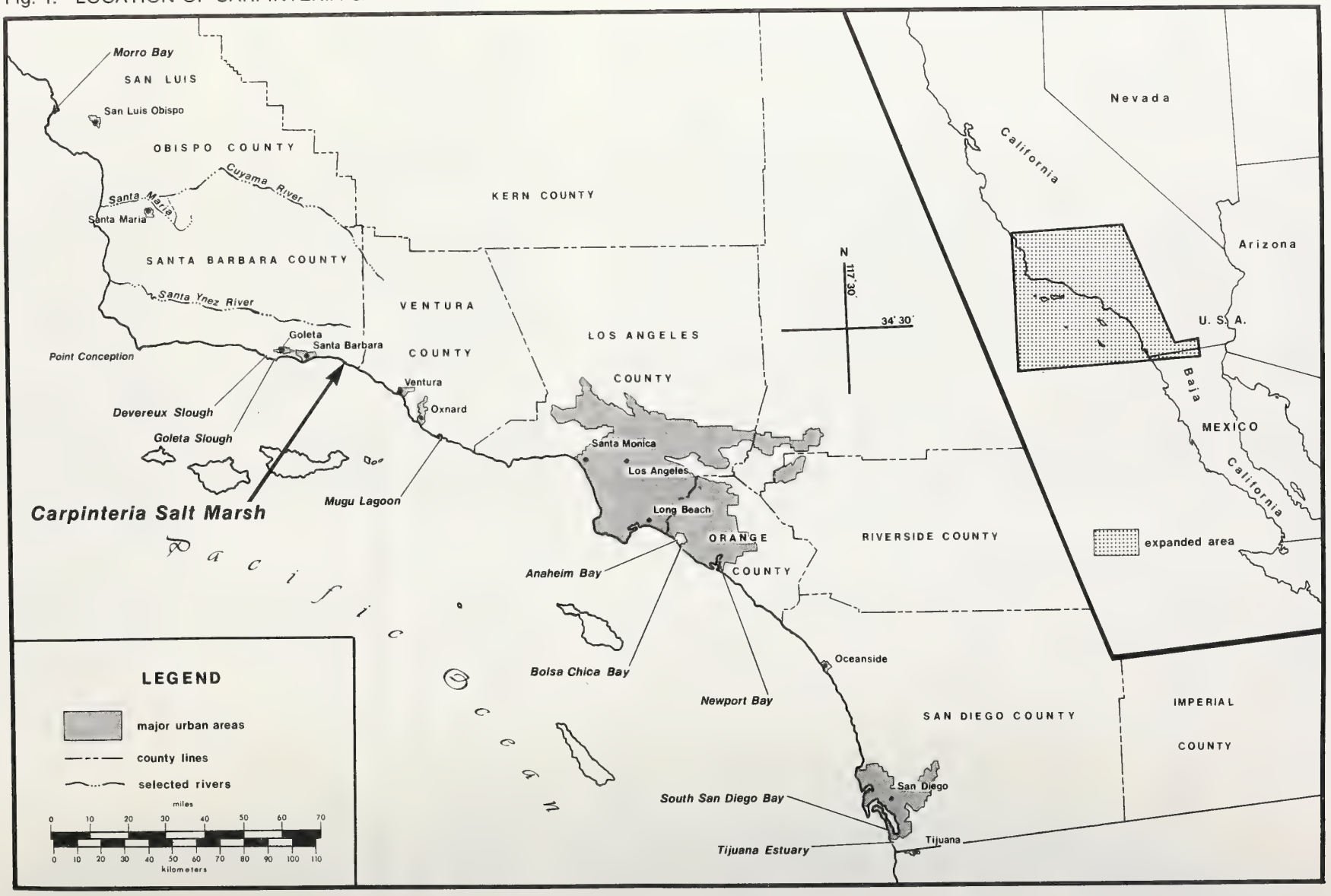


Fig. 2. **CARP**

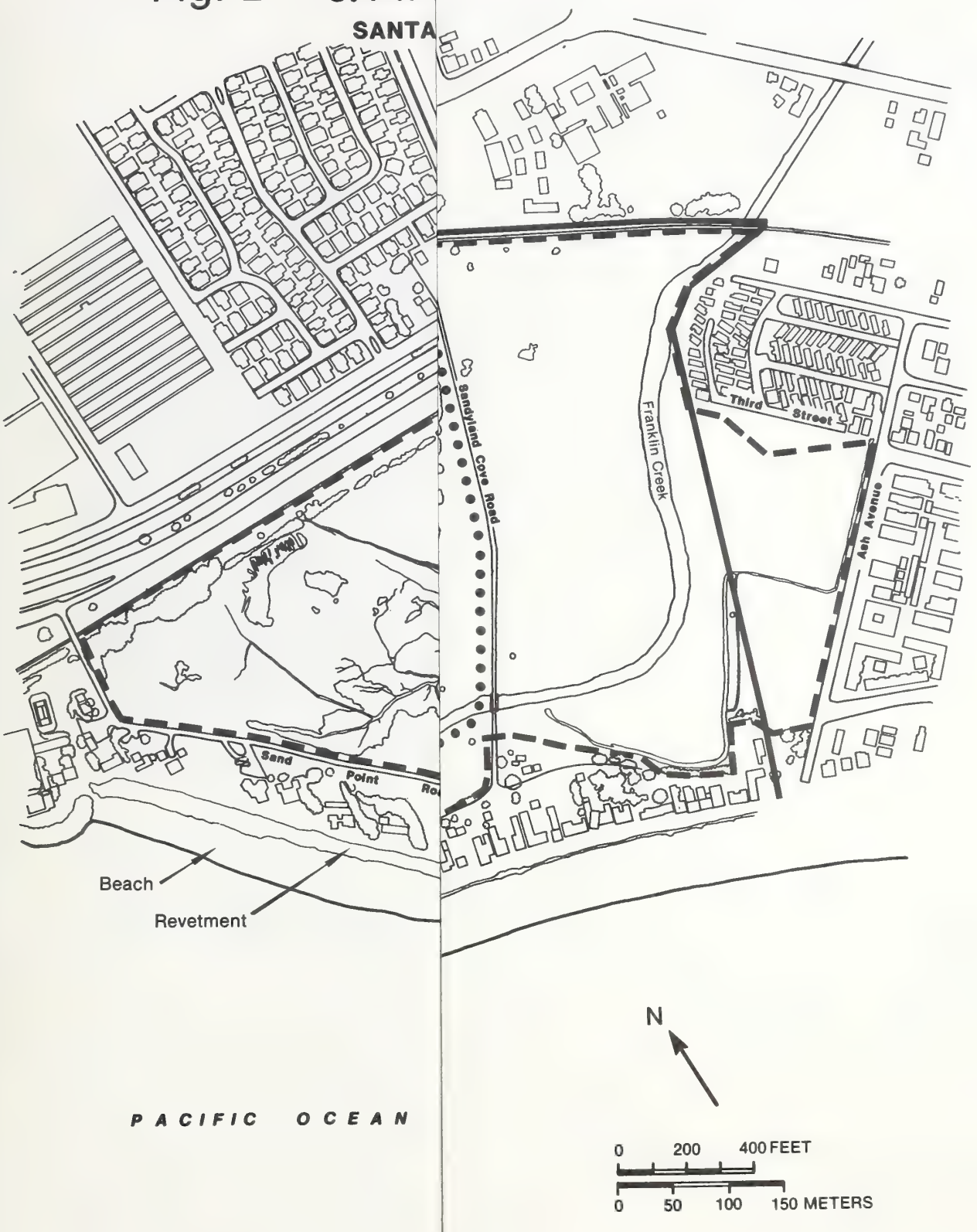

SANTA
Sandyland Cove Road
Franklin Creek
Third Street
Ash Avenue
Sand Point
Beach
Revetment
PACIFIC OCEAN
N
0 200 400 FEET
0 50 100 150 METERS

Fig. 2. **CARPINTERIA SALT MARSH**

SANTA BARBARA COUNTY, CALIFORNIA

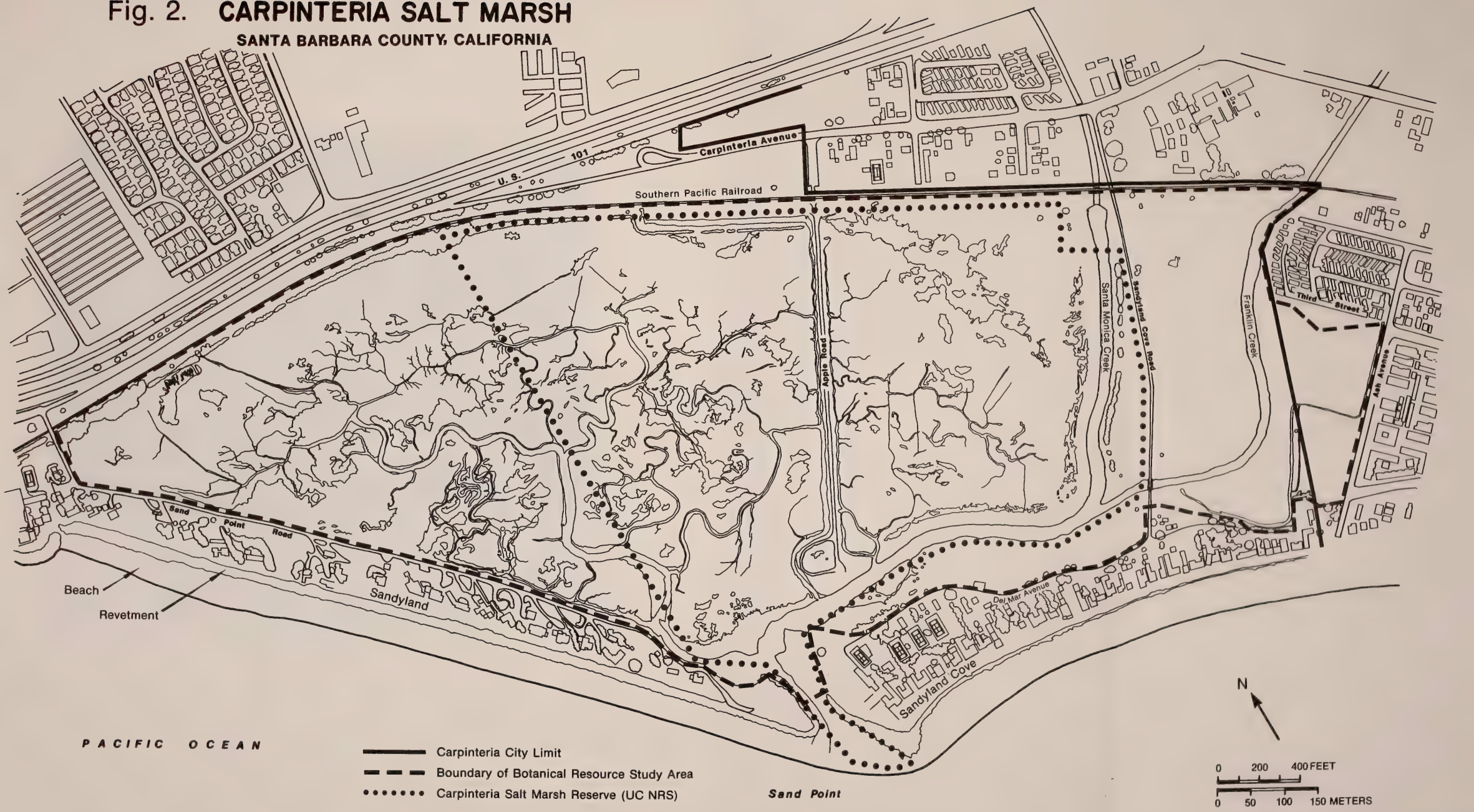




Fig. 3. CARPINTERIA SALT MARSH: View northeastward across the estuary and Carpinteria Valley to the Santa Ynez Mountains. Sandyland occurs on a sand spit (lower left and center) along the ocean side of Carpinteria Salt Marsh, and the western portion of Sandland Cove is visible in the lower right, east of the mouth of the estuary. Apple Road trends southward into the salt marsh from Carpinteria Avenue and the Old Town section of Carpinteria. The estuary extends beyond the photograph, eastward to the City of Carpinteria and westward to Sand Point Road at Santa Claus Lane. Residential, commercial, and agricultural development are evident on the coastal plain, and agriculture extends into the foothills. Photograph by J. Robert Haller in 1970.

winds that blow parallel to the coast. During spring months the daytime wind patterns are similar to those of winter, but they are stronger. Summer months are characterized by stabilized weather, having calm morning conditions and light to moderate onshore air movement in the afternoon. During fall months continental cooling generates offshore breezes at night that can be strong in large canyons such as those in the vicinity of Carpinteria.

Fog is an important characteristic of the Carpinteria Valley. The coastline of southern California is subjected to an inversion layer that traps cool, moist air at low elevations, producing fog or low clouds during the night and early morning hours. As the inversion layer rises slowly during the day, the fog evaporates. Fog develops more frequently during late spring and early summer mornings when warmer air comes in contact with the cool ocean water. Fog is then drawn over land--a process usually associated with seasonal warming of the interior. As ocean temperatures increase during the summer, the occurrence of fog decreases.

Temperature and precipitation data have been recorded for Santa Barbara and the Santa Barbara Municipal Airport, approximately 12 miles (19.4 km) and 19 miles (30.6 km) west of Carpinteria Salt Marsh, respectively. However, because of incomplete records at Santa Barbara and because of the proximity of the Airport to another estuary, Goleta Slough, a summary of the past 10 years data has been provided for only the Airport (Table I). Summaries of data for both stations have been provided for earlier periods (Table II).

Temperature data (Table I) reveal that during the past 10 years, including 6 years of the botanical evaluation, the Santa Barbara region was characterized by typically low seasonal range in temperature. This is illustrated by the average temperature in the warmest month (August) that was only 14.1°F higher than the average temperature in the coolest month (December). Similar differences in average temperatures between warmest and coolest months were recorded (Table II) during earlier periods of time for Santa Barbara (1894-1930, 13.4°F; 1931-1952,

15.2°F; 1941-1970, 14.3°F) and the Santa Barbara Municipal Airport (1931-1952, 13.8°F; 1941-1970, 14.1°F). Although some temperatures below freezing are recorded (Table I), the average minimum temperature in the coldest month is above freezing. Similarly, although there are temperatures recorded over 100°F, the average maximum temperature was about 75°F and occurred in August. These conditions are due in large part to the maritime location.

Precipitation in the Santa Barbara region has a Mediterranean pattern: winter rain and summer drought. During the past 10 years (Table III), 89.8% of the average monthly precipitation fell during a six-month period (November through April). The average rainfall for this period was 18.79 inches (48.2 cm) compared to only 2.14 inches (5.5 cm) that occurred from May through October. Similar patterns of rainfall have been recorded (Table IV) for earlier periods at Santa Barbara and the Santa Barbara Municipal Airport. The average annual precipitation at Santa Barbara for the period 1867 to 1979 is 17.8 inches (45.6 cm); however, fluctuations in annual precipitation are considerable [e.g. 7.83 inches (19.9 cm) in 1975-1976, and 36.67 inches (93.1 cm) in 1982-1983--Table III]. Heavier precipitation, including some snow, is recorded for higher elevations in the Santa Ynez Mountains. Most rain-bearing storm systems come from the northwest in winter. Infrequent summer rains may occur from tropical air masses but are generally of little consequence to plant growth.

Thus, the botanical resources of Carpinteria Salt Marsh are supported by a regional climate characterized by coastal winds and morning fog, consistently mild air temperatures that rarely dip below freezing, and variable, largely winter rainfall.

Geology - The structural, stratigraphic and historical geology of the Carpinteria region have been investigated by Chaney and Mason (1934), Upson (1951), Dibblee (1966), Jackson (1980), and Jackson and Yeats (1982). The following summary has been adapted from their work, particularly that of Jackson and Yeats, and provides important

TABLE I. 1974-83 TEMPERATURE DATA - Santa Barbara Municipal Airport (elev. 9 ft.) (Environmental Data Service, 1974-1983).

MONTH	Temperature (°F)				
	MAX	AV MAX	AV	AV MIN	MIN
JAN	81	63.7	52.8	41.8	25
FEB	86	58.4*	54.3	44.2	33
MAR	84	64.9	55.4	46.1	29
APR	84	64.6	56.7	47.0	37
MAY	91	67.8	59.2	50.5	39
JUN	97	72.1	63.0	53.9	44
JUL	105	73.9	65.5	57.1	49
AUG	91	75.1	66.9	58.6	48
SEP	104	75.0	66.6	58.1	47
OCT	93	72.6	62.5	52.5	36
NOV	93	69.1	56.8	44.5	31
DEC	83	65.2	53.1	36.7**	29

* - probably inaccurate; average too low, may be nearer 64°.
** - probably inaccurate; average too low, may be nearer 42°.

TABLE II. AVERAGE MONTHLY TEMPERATURES (Weather Bureau, 1930, 1952; Environmental Data Service, 1973, 1974-1983).

	Santa Barbara elev. 100-130 ft. (1&2), 5 ft. (3)			Santa Barbara Municipal Airport elev. 12' (4&5), 9' (6)		
	1	2	3	4	5	6
	1894-1930	1931-1952	1941-1970	1931-1952	1941-1970	1974-1983
JAN	53.4	52.0	53.2	51.0	51.6	52.8
FEB	54.7	53.5	54.6	52.9	53.3	54.3
MAR	55.8	55.7	55.9	54.7	54.7	55.4
APR	57.9	58.4	58.4	57.6	57.3	56.7
MAY	59.5	61.0	60.6	60.0	59.7	59.2
JUN	62.4	62.9	63.1	61.9	62.0	63.0
JUL	65.7	66.7	66.6	64.6	65.1	65.5
AUG	66.8	67.2	67.5	64.8	65.7	66.9
SEP	65.7	66.4	66.8	64.5	65.0	66.6
OCT	62.7	63.0	63.4	61.2	61.6	62.5
NOV	59.1	58.0	58.6	56.9	57.0	56.8
DEC	55.1	54.0	54.5	53.1	52.0	53.1
AV	59.9	59.9	60.3	58.4	58.8	59.4

TABLE III. 1973-83 PRECIPITATION DATA - Santa Barbara Municipal Airport (elev. 9 ft.) (Environmental Data Service, 1973-1983).*

MONTH	TOTAL PRECIPITATION (inches) T = trace										
	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	AV
JUL	T	0.01	T	T	0.00	0.00	T	0.40	0.00	0.00	0.04
AUG	0.01	T	0.01	T	0.26	0.02	T	T	T	0.00	0.03
SEP	T	T	T	4.13	T	1.27	0.41	T	T	1.40	0.72
OCT	0.35	0.59	0.35	2.40	T	T	0.59	0.01	0.87	0.66	0.58
NOV	1.42	0.06	0.15	1.10	0.10	1.59	0.66	T	1.97	6.34	1.34
DEC	1.43	5.58	0.07	1.07	4.40	1.11	2.10	0.90	0.74	1.72	1.91
JAN	7.73	0.53	0.00	3.60	8.52	4.74	5.92	3.76	2.89	8.89	4.66
FEB	0.22	4.96	5.00	0.19	10.51	3.88	8.14	3.49	0.45	8.07	4.49
MAR	4.60	5.18	1.17	1.54	10.08	5.57	2.00	6.83	5.19	4.92	4.71
APR	0.19	1.05	0.89	0.00	2.00	T	0.50	0.40	2.11	4.55	1.17
MAY	T	0.09	T	1.03	0.00	0.04	0.21	T	0.00	0.12	0.15
JUN	T	T	0.19	0.04	0.01	T	0.00	T	0.00	T	0.02
TOTAL	15.95	18.05	7.83	15.10	35.88	18.22	20.53	15.79	14.22	36.67	19.82

TABLE IV. TOTAL PRECIPITATION (inches) (Weather Bureau, 1930, 1952; Environmental Data Service, 1973, 1974-1983).*

	Santa Barbara elev. 100-130 ft. (1&2), 5 ft. (3)			Santa Barbara Municipal Airport elev. 12' (4&5), 9' (6)		
	1	2	3	4	5	6
	1894-1930	1931-1952	1941-1970	1931-1952	1941-1970	1974-1983
JUL	0.02	0.04	0.03	0.08	0.04	0.04
AUG	0.02	0.06	0.01	0.01	0.01	0.22
SEP	0.38	0.06	0.07	0.05	0.07	1.04
OCT	0.75	0.60	0.38	0.42	0.35	0.67
NOV	1.45	1.23	2.16	1.52	1.94	1.49
DEC	3.07	4.04	2.66	3.20	2.49	2.27
JAN	4.13	3.65	3.94	2.85	3.47	4.66
FEB	3.61	3.80	3.41	2.06	3.02	4.49
MAR	2.91	3.16	2.61	2.61	2.39	4.71
APR	1.16	1.17	1.80	0.93	1.54	1.17
MAY	0.46	0.26	0.27	0.20	0.18	0.15
JUN	0.08	0.10	0.07	0.02	0.03	0.02
TOTAL	18.04	18.17	17.41	13.95	15.53	20.93

*Data are arranged according to seasonal rainfall, not calendar years.

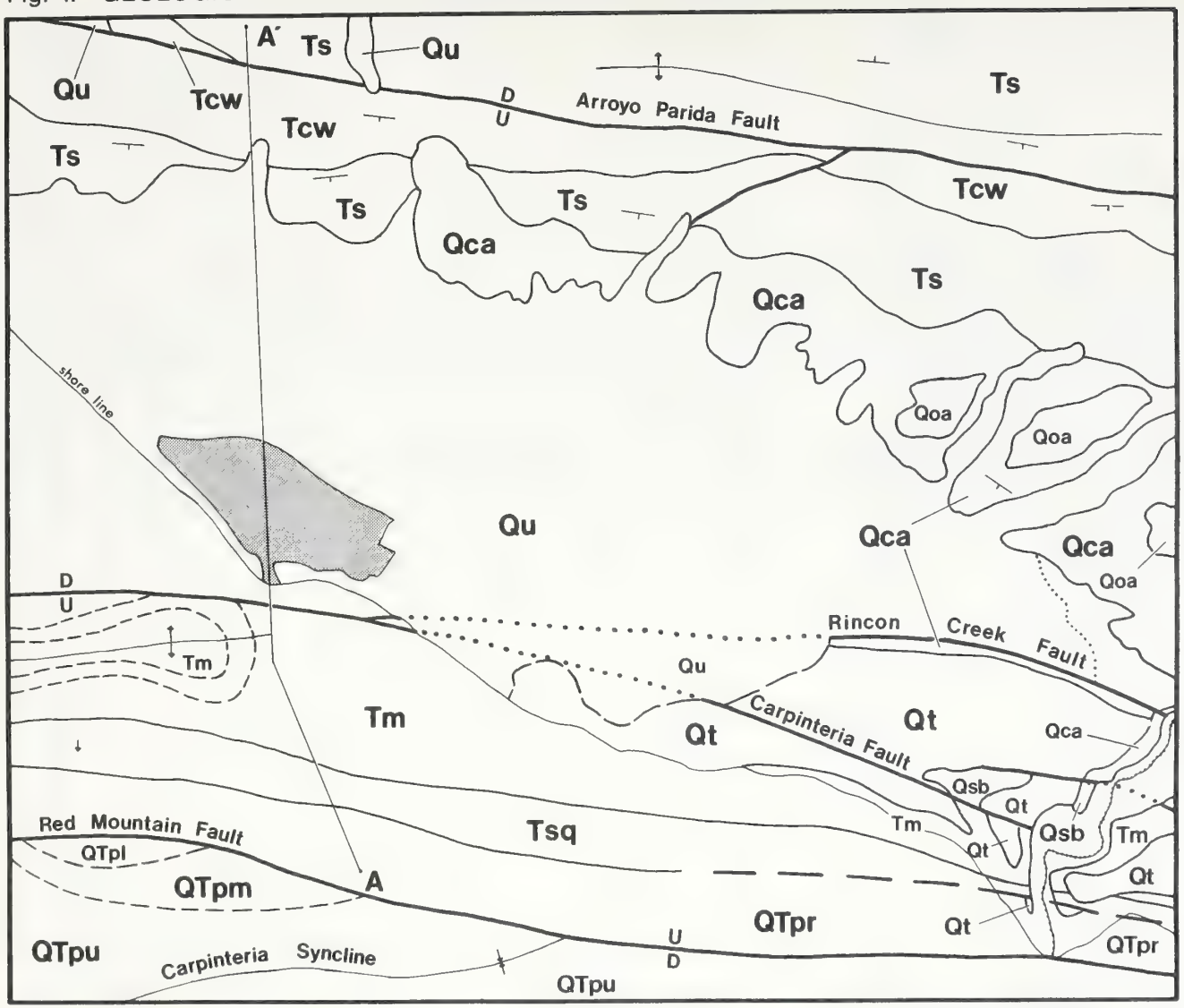
background information on the origin and evolution of the Carpinteria Valley and Carpinteria Salt Marsh.

Structurally, the Carpinteria Valley or basin is an east-trending, northward verging, faulted syncline containing intertongued shallow marine and nonmarine Pleistocene sediments from several hundred to several thousand feet thick deposited on older folded rocks (Figs. 4 & 5). Approximately one million years (Ma) ago the Carpinteria area was the northern margin of the offshore Ventura basin. Uplift north of the Red Mountain Fault (Fig. 4) separated the Carpinteria basin during middle to late Pleistocene time, and today the basin is located along the northeastern coast of the Santa Barbara Channel between the Santa Ynez Mountains to the north and the Ventura Basin to the south.

The earliest rocks of the lower sequence in the region were deposited between the late Cretaceous Period and the late Miocene epoch of the Tertiary Period (ca. 75 Ma to 10 Ma ago). During this time there were several periods of subsidence and uplift in basins that occurred throughout what is now the western Transverse Range Province. The rocks deposited during that time include medium to coarse-grained sandstones and conglomerates such as the marine Cozy Dell and Coldwater Formations, the non-marine Sespe Formation, and the thin marine Vaqueros conglomerate. Overlying these rocks is a series of younger marine deposits, including mudstones and claystones of the Rincon and Monterey Formations.

Initial rise of the Santa Ynez Mountains occurred during the Pliocene Epoch (ca. 5-2 Ma ago) and by the end of the Pliocene this mountain range and the Ventura basin had largely achieved their present configurations. The Pico Formation was deposited during Pliocene and Pleistocene time, and stratigraphic evidence within it suggests that during this time the area north of the Red Mountain fault was probably higher than the area to the south of it. The Santa Ynez Mountains apparently became emergent during early or middle Pliocene time. Folding along the southern margin of these mountains formed many of the structures that occur beneath the Carpinteria basin. An interval of

Fig. 4. GEOLOGIC MAP OF THE CARPINTERIA SALT MARSH AREA



LEGEND

	Carpinteria Salt Marsh
Qt	marine terrace
Qu	non-marine terrace
Qoa	older alluvium
Qca	Casitas Formation
Qsb	Santa Barbara Formation
QTpu	Upper Pico Formation
QTpm	Middle Pico Formation
QTpl	Lower Pico Formation
QTpr	Repetto Formation
Tsq	Sisquoc Formation
Tm	Monterey Formation
Tv	Vaqueros Formation
Ts	Sespe Formation
Tcw	Coldwater Formation
—	strike and dip
+	anticline
+	syncline

D - down U - up

Modified from Jackson, 1980

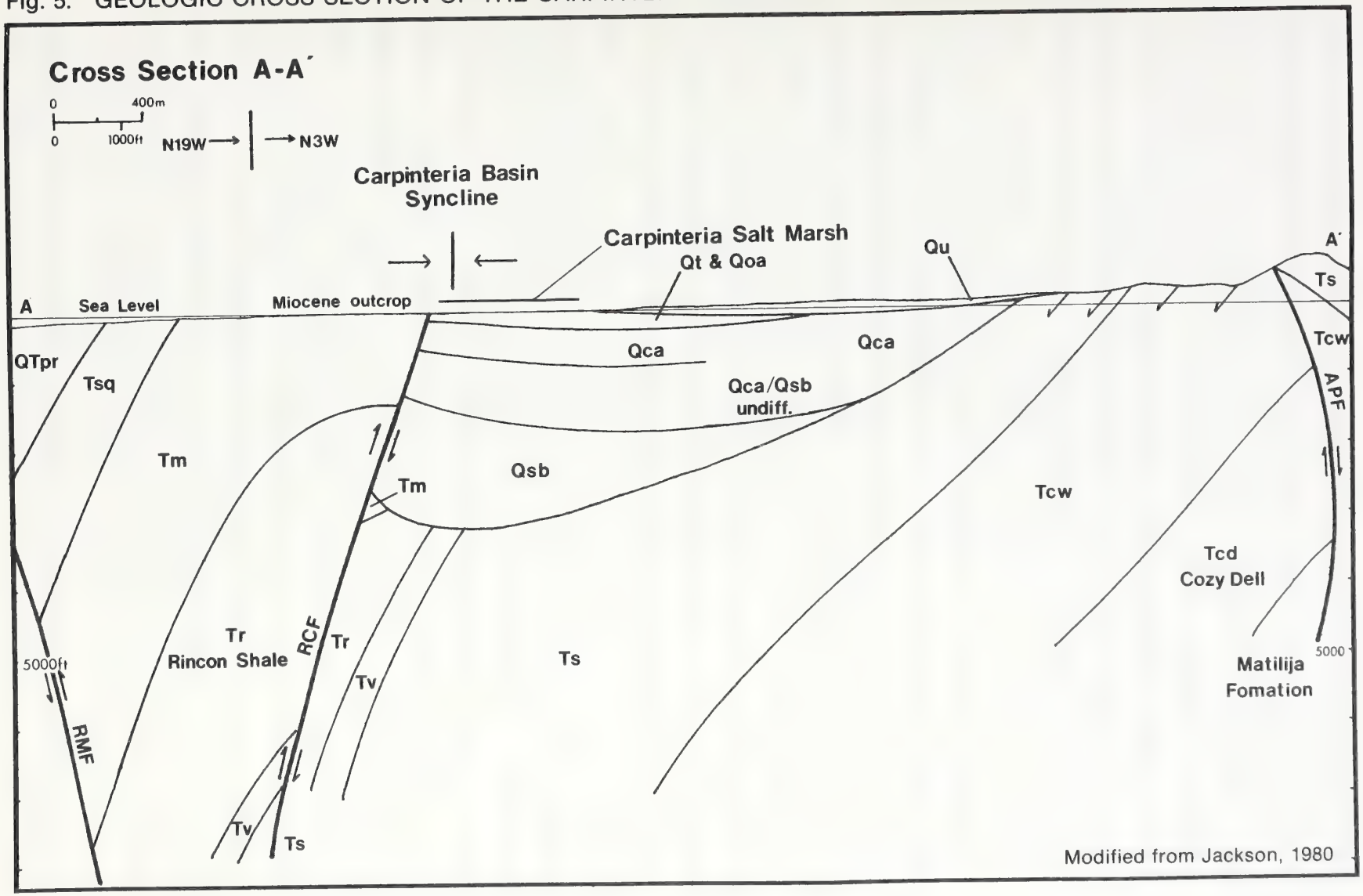
major uplift and erosion of the entire coastal area occurred prior to the deposition of most Quaternary sediments.

During the Pleistocene Epoch of the Quaternary Period, the Santa Barbara Formation was deposited in the shallow edge of a sea that was transgressing over the previously eroded surface of the coastal plain. This formation consists of rocks that include fine- to medium-grained fossiliferous sandstone and siltstone, interbedded with claystone and conglomerate. Deposition began about 1.2 Ma ago following which (1.2-0.6 Ma ago) there was uplift along the Red Mountain fault, separating the northern Ventura basin from the Carpinteria basin. This produced a basinal structure that eventually filled with sediment to become the Carpinteria Valley. Movement along the Red Mountain fault has caused the structural isolation of the Carpinteria basin, although various faults within the basin control its shape (Jackson and Yeats, 1982). Carpinteria Salt Marsh is what remains of a larger historic bay or estuary that formed in the basin.

With continued sedimentation, the Carpinteria basin became quite shallow and eventually a large alluvial fan complex began to cover portions of it. These nonmarine sediments belong to the Casitas Formation, composed of detritus derived from the rising Santa Ynez Mountains. The lower part of the Casitas formation consists of a lower section of thin-bedded, fine-grained, non-fossiliferous sandstone, siltstone, and conglomerate, and the upper section of poorly sorted and poorly stratified pebble to boulder conglomerate. The Casitas formation is found throughout the Carpinteria basin north of the Rincon fault.

Major movements along faults displaced the Casitas and Santa Barbara Formations by several thousand feet and ended the earlier pattern of continental deposition. The general extent, shape and depth of ground water basins were determined by these fault movements, and erosion of the Casitas and Santa Barbara Formations continued until the coastal area was submerged again in late Pleistocene and early Holocene time. During this time marine sediments were deposited unconformably on the older formations. These sediments consist of a fossiliferous basal

Fig. 5. GEOLOGIC CROSS SECTION OF THE CARPINTERIA VALLEY



marine beach gravel and sand deposited on wave-cut platforms, and are covered by non-marine stream sand and gravel deposits. Emergence of the coast has resulted in erosion of these Pleistocene and Holocene sediments, and remnants are referred to as terrace deposits. Today terrace deposits occur east and south of Carpinteria. Two beds have been dated at about 45,000 and 4,500 years old, respectively. Terrace deposits probably extended seaward during the relatively sharp drop in sea level that probably corresponded to the advance of continental glaciers during the Wisconsin stage of the late Pleistocene.

Varying erosional and depositional processes occurred along the South Coast depending on local geological phenomena. For example, in the Goleta basin streams excavated valleys that were graded to sea level more than 200 feet (61 m) lower than today (Upson, 1949). However, in the Carpinteria basin deposition may have continued through Pleistocene time, perhaps as a result of intermittent subsidence of the area along the Rincon, Carpinteria, or Red Mountain faults, and the continued access of the basin to the ocean. In discussing the history of infilling in Goleta Slough, Lohmar et al. (1980) concluded that many of the small estuaries and lagoons along the coast of southern California were probably created about 5-7,000 years ago when rising sea level flooded the incised drainages cut during the Wisconsin glacial period (10-60,000 years ago). This rise in sea level averaged about 40 feet (12 m) each 1000 years until about 5000 years ago when sea level approached that of today (Zedler, 1982). Based on the evidence available for the Carpinteria Valley, it appears that a marine basin or estuarine lagoon may have characterized the region long before this flooding event. Norris (personal communication, 1985) suggests, however, that the present estuary is the result of deposition of a sandbar caused by a rocky reef that is exposed only at the lowest tides. The reef, apparently part of the southern limb of the syncline, occurs just beyond the mouth of the estuary and provides enough of a wave barrier to cause deposition of the sandbar behind it and a realignment of the coast.

Late Pleistocene terrestrial plant and animal remains preserved in asphalt deposits were discovered in 1927 just east of the mouth of

Carpinteria Creek. Chaney and Mason (1934) conducted extensive studies on the plant material from the commercial "tar pits" at the site and their analysis of the fossils provides insight into the vegetation and climate of the Carpinteria Valley during late Pleistocene time. Furthermore, the plant and animal life from the deposits have been considered (Savage et al. 1954) to be an unrivaled balanced sample of land plants, mammals, birds and marine mollusks of the same geological age. The tar pits occur in the older alluvium, the "Carpinteria Formation" of Chaney and Mason (1934), that lies unconformably across the upturned edges of the Monterey Formation, and represents one of the Pleistocene terrace deposits. Oil migrated into structurally deformed strata of the region during late Pleistocene time (Jackson and Yeats, 1982). The "Carpinteria Formation" includes upper beds of light-colored, cross-bedded sand with asphalt stain, but usually no fossils; and lower beds of sand, gravel and cobbles, heavily impregnated with asphalt containing abundant fossil plants and animals. It is often overlain by recent dark gray sands that contain small amounts of asphalt and numerous shells and implements representing midden deposits. Because the asphalt springs are still active, they have penetrated both alluvial and beach sands.

The most abundant large specimens of plants from the deposits are those of Pinus radiata (Monterey Pine) and the most abundant plant remains are those of Arctostaphylos spp. (manzanita). A number of the specimens have a worn appearance suggesting transportation by water. Chaney and Mason (1934) interpreted the remains on the basis of the modern occurrence of living species and concluded that the flora apparently contained three distinct vegetation types: Monterey Pine Forest, well represented by 24 species that probably occurred near the site; Coast Redwood Forest, poorly represented by two species that probably occurred on the coast some distance away; and Digger Pine-Juniper Forest, poorly represented by 3 species that probably occurred on dry hills back from the coast. In addition to many small mammals and birds, extinct large animals represented in the deposits include the dire wolf, giant cat, camel, horse and bison. The sediments containing this fossil assemblage were deposited in and near the valleys of streams, probably those ancestral to the Carpinteria Creek system, that flowed down from

the mountains, southward to the ocean at a point not far south of the present coastline. West of these deposits, the "Carpinteria Formation" lacks most of the coarser sediments and terrestrial fossils, and is characterized by finer sediments containing marine organisms. Thus, part of this formation was deposited in a lagoon or along a shore (Chaney and Mason, 1934). This depositional environment may have represented the estuary ancestral to Carpinteria Salt Marsh.

The environmental conditions of the Carpinteria region in late Pleistocene time were apparently similar to those now characteristic of the Monterey Peninsula. Most of the plants of the Carpinteria Pleistocene flora are currently members of the Monterey Pine Forest community that occurs about 200 miles (322 km) northwest of Carpinteria Valley. The passerine birds and assemblage of mammals found in the deposits also are consistent with an open pine forest habitat. Apparently, conditions at the time of deposition were cooler and slightly more humid than the current climate of the Carpinteria region. The return of warmer, drier conditions resulted in a northward shift of the forest to its present position (Chaney and Mason, 1934).

With the Holocene transgression came submergence of the excavated valleys of the Goleta basin and further submergence of the Carpinteria basin. The Holocene younger alluvium of the geologic sequence consisted of mud and silt deposited on alluvial plains and in swamps, and sands and gravels in stream channels. In the Goleta basin this younger alluvium is easily distinguished from the late Pleistocene older alluvium deposits. In portions of the Carpinteria basin water wells have shown that the younger alluvium is as much as 225 feet (69 m) thick and is continuous with the older alluvium or the nonmarine deposits of the Casitas formation. In the Carpinteria Valley such deposition continues to the present time.

Drainage - The Carpinteria Valley (basin) includes the lowest parts of a major drainage system. This system contains the watersheds of Rincon, Gobernador, Carpinteria, Franklin and Santa Monica Creeks, and streams in Arroyo Parida and Toro Canyon. These streams are short,

all but two have separate drainage basins, and generally have perennial flows in the headwater areas, but do not have perennial surface flows across the coastal plain. The drainage system of Carpinteria Valley is composed of three parts (Thomasson, 1951). The mountainous headwater area covers about 37 square miles (95.83 sq. km) and is composed of consolidated rocks, largely the Sespe and Coldwater Formations, that are overlain in most places by less than three feet of rocky soil. These formations extend from the foothills and the Santa Ynez Mountains down slope to the upper edge of unconsolidated deposits. It is the principal area of surface water runoff, and is covered by chaparral vegetation for the most part, or by avocado groves in the foothills and lower slopes.

The groundwater basin of this system occurs adjacent to the area of consolidated rocks and consists of two parts. The marginal parts of the basin extend along the base of the mountains, cover about 7 square miles (18 sq. km), and are underlain by unconsolidated deposits that range in thickness from several feet to about 1000 feet (305 m). These deposits, including alluvium, terrace deposits, and the Casitas and Santa Barbara Formations, contain a significant amount of water and are the only ones that absorb large amounts of surface water runoff from rain and streams. This groundwater basin recharge area was covered historically by mostly grassland or Coastal Sage Scrub, but today is characterized by agriculture or other forms of development. The central or lower portion of the groundwater basin, and the third part of the drainage system, covers about 5 square miles (13 sq. km). Like the recharge area, it also is underlain by unconsolidated deposits that reach a thickness of about 2000 feet (610 m). However, impermeable beds occur near the surface in the central portion of the basin and prevent the downward movement of rain, irrigation, and stream water into the deeper groundwater-bearing beds. This water is discharged directly from the shallow groundwater body. Carpinteria Salt Marsh occurs in the area of impermeable beds.

The watershed of Carpinteria Salt Marsh is confined to the drainage of Franklin and Santa Monica Creeks (Fig. 6) and related coastal plain runoff and drainage ditches. The Franklin Creek subwatershed drains

about 2,732 acres (1107 hectares) and reaches an elevation of 1,746 feet (533 m); the Santa Monica Creek subwatershed drains about 3,853 acres (1561 hectares) and reaches an elevation of 3,853 feet (1175 m) (Woodward-Clyde, 1982). Santa Monica Creek extends about 5 miles (8 km) southward from the crest of the watershed to Carpinteria Salt Marsh, where it joins Franklin Creek before reaching the mouth of the estuary. Franklin Creek extends about 4 miles (6.5 km) southwestward from the foothills of the Santa Ynez Mountains to the confluence of the creeks. Historically, Carpinteria Creek to the east and Arroyo Parida to the west also flowed into this estuary, but this was previous to extensive infilling due to the deposition of alluvial fans and expanding urbanization.

Local streams are characterized by flash floods that follow rainstorms and by a gradual decline of discharge during the dry summer and autumn. Extensive erosion associated with infrequent large floods results in the deposition of large quantities of sediment and debris in the basin, and has accounted for much of the infilling of Carpinteria Salt Marsh. Such catastrophic events have been documented for other estuaries in southern California (Lohmar et al., 1980; Zedler, 1982). Carpinteria Salt Marsh is particularly vulnerable because it is located next to the steep slopes of the Santa Ynez Mountains and in an area characterized by various forms of development that have increased the rate of erosion in the watershed, resulting in the rapid expansion of alluvial fans into the estuary. Furthermore, Carpinteria Salt Marsh is situated in the trough of a syncline into which at least 4 streams flowed historically, and not at the mouth of a large river or in an area with more consistent rainfall where adequate flushing might remove sediments instead of allowing them to accumulate. Continued subsidence of the basin through much of the late Tertiary and Quaternary Periods accommodated the deposition of sediment. However, Carpinteria Salt Marsh, like other southern California estuaries such as Goleta Slough and Mugu Lagoon, will be filled without management of erosion in the watershed, runoff, and sedimentation in the estuary, given a constant sea level.

Fig. 6. WATERSHED MAP OF THE CARPINTERIA SALT MARSH AREA



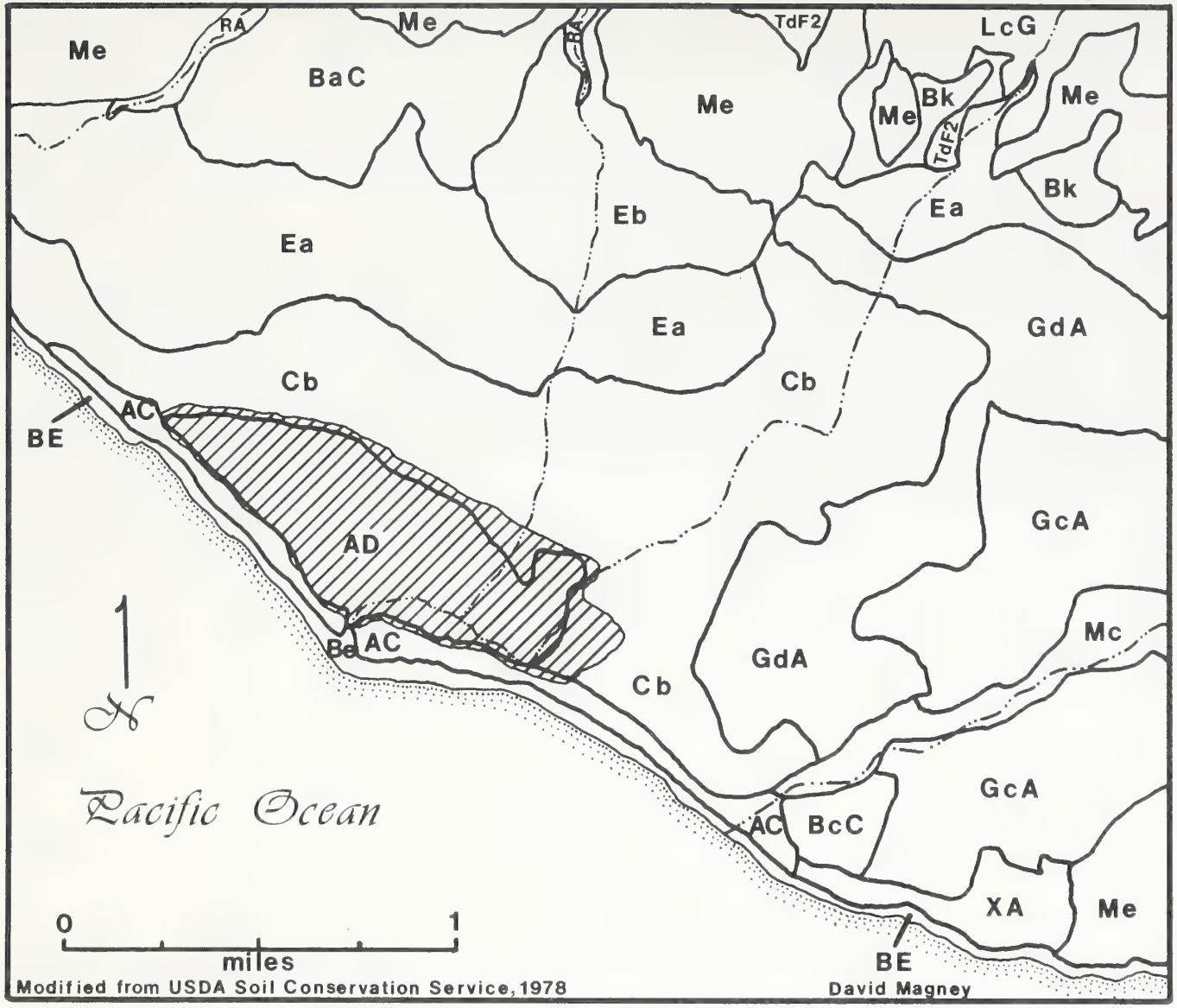
Fig. 6. WATERSHED MAP OF THE CARPINTERIA SALT MARSH AREA: Carpinteria Salt Marsh is the basin for that portion of the Carpinteria Valley watershed drained by two streams and several minor drainages. Presently the mountain, foothill, and coastal plain areas that drain into the estuary are included in the Franklin and Santa Monica Creek subwatersheds. A third subwatershed north of the western end of the estuary is a coastal plain area drained by several ditches. Historically, Carpinteria Creek to the east and Arroyo Parida Creek to the west also flowed into Carpinteria Salt Marsh.

Soils - Soils of the Carpinteria Valley in the immediate vicinity of the estuary (Fig. 7) have developed on the alluvial fans, floodplains and tidal flats that characterize the region, and are derived mostly from the Santa Ynez Mountains. They have been described and mapped by Shipman (1981), and this information is summarized below. The Camarillo-Aquepts association consists of nearly level, poorly drained to very poorly drained, fine sandy loams on low floodplains and tidal flats. Flooded Aquepts are nearly level soils that are periodically covered by tidal water. Most of the estuarine soils are flooded by exceptionally high tides, while others are flooded daily. They are usually highly stratified thin layers of coarse to fine textured mineral soil with occasional layers of peat. They are almost continually waterlogged, very saline and support salt-tolerant hydrophytes. Flooded Aquepts are very poorly drained and variable in permeability. The surface runoff is slow and often ponded. All of Carpinteria Salt Marsh, including most of the alluvial fan deposits of Santa Monica and Franklin Creeks, were mapped by Shipman (1981) as flooded Aquepts.

Camarillo Variant soil of the alluvial deposits north of and adjacent to the estuary is a fine sandy loam characteristic of low alluvial plains (Fig. 7). It has slow drainage and may have standing surface water during winter rainy periods. The water table is 3 to 6 feet below the surface in summer and fall and 1 to 2 feet below in the winter and spring. Stream overflow and deposition of detritus is characteristic of these low areas and the salinity is usually slight to moderate. Native vegetation cover is mainly annual grasses, cattails, sedges and willows. The soils have been drained for agriculture, but growth of crops is spotty and erratic. Urbanized portions are threatened by occasional flooding.

The Goleta-Elder-Agueda association of soils occurs on nearly level to moderately sloping, well drained, sandy loams, fine sandy loams, loams, and silty clay loams on floodplains and alluvial fans and in valleys (Fig. 7). In the Carpinteria Valley the Elder sandy loam, with 0 to 2 percent slopes, occurs north of and adjacent to the band of Camarillo soil. It characterizes alluvial fans, that were apparently

Fig. 7. Soil Map of Carpinteria Salt Marsh and Vicinity



LEGEND

AC	AQUENTS fill areas (& dunes)
AD	AQUEPTS flooded
BaC	BALLARD fine sandy loam
BcC	BAYWOOD loamy sand
BE	BEACHES
Bk	BOTELLA VARIANT silty clay loam
Cb	CAMARILLO VARIANT fine sandy loam
Ea	ELDER sandy loam
Eb	ELDER-SOBODA Complex
GcA	GOLETA fine sandy loam
GdA	GOLETA loam
LcG	LODO-SESPE Complex
Mc	METZ loamy sand
Me	MILPITAS-POSITAS fine sandy loams
RA	RIVERWASH
TdF2	TODOS-LODO Complex
XA	XERORTHENTS cut & fill areas

STREAMS

CARPINTERIA SALT MARSH

deposited by Franklin and Santa Monica Creeks, and occurs on low slopes rather than flat areas of the alluvial plains. This soil is developed on stratified alluvium and has a surface layer of dark sandy loam, and an underlying layer of stratified and variously colored, loamy sand, sandy loam, fine sandy loam, loam, and silty clay. It is neutral in the surface layer and mildly alkaline in the underlying layer. The soil is moderately permeable, runoff is slow, and the effective rooting depth for plants is more than 60 inches. Some areas of Elder soil are occasionally flooded and deposition from overflowed streams can occur. The native vegetation cover is annual grasses, forbs, and scattered oak trees; however, the soils are used extensively for orchards, field and row crops, and flowers. Urban development has encroached in many areas.

Additional soil types are found on steeper slopes and higher elevations in the watershed of Carpinteria Salt Marsh. Likewise, the soils associated with Carpinteria Creek (Fig. 7) are different from those in the immediate vicinity of the present boundaries of Carpinteria Salt Marsh. For example, the streambed of this creek is characterized by Metz loamy sand, usually found in low-lying areas adjacent to major streams, and by Goleta loam and fine sandy loam characteristic of valleys and broad floodplains. This area supported a dense grove of oak trees historically, but today supports field and row crops, and groves. It also has been converted extensively to urban development.

Three additional soil types occur adjacent to Carpinteria Salt Marsh. Aquents, fill areas, are present at the mouth of the estuary and other areas along the developed portions of the sand spits. They occur in areas reclaimed for development and are composed of variable types of soil material used for fill. Dune Land consists of various types of mounds, flats, hollows, etc., that are characterized by aeolian marine sands. Most of this soil has been obscured by residential development and stabilized by various exotic plant covers, although some native dune vegetation still occurs. Beaches occur along the Pacific Ocean margin of the sand spits and at the mouth of the estuary and are generally narrow, sandy strips flooded during high tide. Extensive rock revetment

has been constructed as a sea wall between the beach and dune areas to protect residential development from erosion.

Summary - Carpinteria Salt Marsh is an estuary covering about 230 acres and located on the South Coast of Santa Barbara County in southern California. The region is characterized by a semi-arid Mediterranean climate, having coastal winds and morning fog, consistently mild air temperatures that rarely dip below freezing, and variable, largely winter rainfall. The Carpinteria Valley or basin in which the estuary occurs is structurally a syncline that was separated from the Ventura basin by uplift along the Red Mountain Fault about 1.2 to 0.6 million years ago. The basin eventually filled with sediment and Carpinteria Salt Marsh is what remains of a larger historic estuary. Plant fossils from local asphalt deposits indicate that the region was characterized by a Monterey Pine Forest during late Pleistocene time when climatic conditions were cooler and more humid than today.

The watershed of Carpinteria Salt Marsh is confined to the drainage of Franklin and Santa Monica Creeks and related coastal plain runoff and ditches. Historically, Arroyo Parida and Carpinteria Creek also flowed into this estuary, previous to extensive infilling due to the deposition of alluvial fans and expanding urbanization. Catastrophic flash floods associated with infrequent large winter storms are responsible for extensive erosion of the watershed and the deposition of large quantities of sediment and debris in the basin. Carpinteria Salt Marsh is vulnerable to infilling from such events because it is located next to the steep slopes of the Santa Ynez Mountains and in an area characterized by various forms of development that have increased the erosion of the watershed.

Soils in the estuary and immediate vicinity have developed on alluvial fans, floodplains, and tidal flats. They usually consist of nearly level, poorly drained to very poorly drained, fine sandy loams in wetlands and transitional areas, to well drained sandy loams in surrounding uplands. Most of the estuarine soils are flooded by exceptionally high tides, while low marsh areas are flooded daily.

HISTORY



PREHISTORIC PERIOD

HISTORIC PERIOD

CARPINTERIA SALT MARSH RESERVE

STATUS

H I S T O R Y

A number of researchers have reported on the prehistoric and historic periods of the Carpinteria Valley and on the events that have affected Carpinteria Salt Marsh or have revealed aspects of the wetland system that are absent or obscured today. The following summary of this history has been derived largely from Caldwell (1979, 1982), Clark (1962), Rogers (1929), Stockton (1960), and Wilcoxon (1982), and from an interpretation of maps and aerial photographs.

PREHISTORIC PERIOD

Initial habitation of the Carpinteria Valley probably occurred about 9000 years ago (Wilcoxon, 1982). The earliest reliable date for occupation came from cultural materials associated with an archaeological site near Santa Monica Creek that yielded a radiocarbon date of 7300 years old (Wilcoxon, 1984). Early inhabitats of the region were most likely descended from populations associated with the North American Paleo-Indian Cultural Tradition. Locally there is little evidence of Paleo-Indian occupation. However, from discoveries in eastern California and the greater Southwest, we know that these populations specialized in hunting large Pleistocene mammals and settled adjacent to pluvial lakes. The extent of coastal occupation may never be known because coastal sites occupied during this era are now submerged. With the changing climatic conditions following the Pleistocene and with the reduction in numbers or extinction of large game mammals, human populations became more dependent on a wider diversity of resources including the collection and processing of plant materials and small game for food.

The cultural divisions for the South Coast of Santa Barbara County include the Early, Middle, and Late Periods, and evidence for occupation during each division has been found in Carpinteria Valley. The Early

Period, otherwise referred to as the Milling Stone Horizon or Oak Grove Culture (Rogers, 1929), was the first well-defined cultural tradition in Carpinteria Valley and dates from about 7500 to 5000 years ago (Wilcoxon, 1982). People of the era practiced generalized hunting and gathering techniques and lived adjacent to or near several types of vegetation, including Southern Coastal Oak Woodland, Coast Live Oak Forest, Coastal Sage Scrub and Wetlands. Their villages were often situated on knolls above the lowlands, although there is evidence for occupation along the inland portions of both Carpinteria Salt Marsh and Goleta Slough. Because the climate was wetter than it is now, and hence flooding was probably more frequent, the lowlands were even less suitable for the location of a village than they are today. Evidence presented herein regarding the historical geology of the Carpinteria Valley suggests that at the time of the Early Prehistoric Period the boundaries of the shoreline or inland margin of the estuary apparently extended northward to Foothill Road, eastward to Carpinteria Creek, and westward toward Ortega Hill. Thus, early inhabitants lived on highlands or other sites surrounding and in close proximity to the coastal wetlands.

Important archaeological sites for this cultural tradition include two sites north of the existing estuary of Carpinteria Creek, and at least one each on a ridge overlooking Santa Monica Creek, a knoll east of Toro Canyon, and Ortega Hill (Rogers, 1929; Wilcoxon, 1982). These sites offered protection from floods, a sufficient supply of plant food resources, and convenient perennial sources of freshwater. At the time of settlement the site of Carpinteria Creek must have been situated on a bluff overlooking both the estuary or shallow coastal embayment and the ocean. The well-drained soil at this site has permitted extensive leaching of the substrate and may possibly account for the paucity of shellfish remains (Rogers, 1929) that were otherwise readily available to the inhabitants. The use of marine and estuarine resources by the early people may not have been as extensive as that in later times; however, shellfish remains do occur in older middens on Santa Monica Creek, and thick calcium deposits derived from decomposed shells are commonly noted on artifacts from Early Period sites. Thus, current

evidence suggests that even the earliest inhabitants of Carpinteria Valley utilized the resources of wetlands or shallow marine habitats ancestral to Carpinteria Salt Marsh.

Archaeological sites of the Early Period also have yielded a number of implements that help characterize the people of this time. For example, implements known as metates and manos were apparently made from local sandstone to process small hard seeds of grasses and other plants (Timbrook, personal communication, 1985). Scraper planes also have been hypothesized as plant processing implements (Wilcoxon, personal communication, 1985). Thus, in addition to marine and estuarine resources, plant foods were apparently a very important part of the human diet during the Early Period.

Large land animals (deer, elk, mountain lion, and bear), and marine, estuarine, and riparian resources were characteristic food sources of people of the Middle Period, described by Rogers (1929) as the Hunting People. This cultural adaptation may have replaced the earlier culture over a period of several centuries (Rogers, 1929), and was established locally as early as 5000 years ago (Wilcoxon, 1982). Although archaeological sites from this time are found in a wide variety of habitats on the South Coast and in the surrounding foothills, the sites are often clustered upon headlands near the mouths of canyons or on knolls that bordered estuaries, and show evidence of long periods of use. Implements from these sites include flint weapons, knife blades, large projectile points used with the atlatl or spear thrower, fishhooks, net fishing weights, and stone vessels. The people also had basketry skills and utilized local asphalt to attach baskets to stone mortars as a way to contain plant material as it was being ground. During this period acorns became a staple food and continued as such well into the historic era. Sandstone mortars and pestles are evidence that acorn processing and leaching technology were known. Glassow et al. (1985) suggest that a shift from the exploitation of small seeds to acorns around 6000 years ago may reflect environmental changes that reduced proportionately the extent of available small seeds to available acorns.

A typical Middle Period site occurs in the vicinity of a spring-fed marsh near the mouth of Carpinteria Creek (Rogers, 1929). The inhabitants were probably attracted to the locality by exposed asphalt, freshwater, and abundant food resources. Also, several species of marsh plants, notably Juncus (rushes) used for basketry, and Scirpus (bulrushes), used for house thatching, occurred nearby. All these resources are present in the vicinity of the site today. Other Middle Period settlements are recorded along Santa Monica Creek. Many high density shell midden deposits occur, the faunal inventory of which Wilcoxon (1982) interprets as "...clearly reflect[ing] a predominant estuarine exploitation pattern..." Thus, inhabitants of the Carpinteria Valley were apparently dependent upon estuarine resources as early as several thousand years ago.

By the beginning of the Late Prehistoric Period, about 1000 years ago, inhabitants along the coast of the mainland and on the California Islands began to rely more heavily upon marine and estuarine resources for a stable and diversified diet (Wilcoxon, 1982). Sometimes referred to as the Canaliño, this group was characterized by a complex culture with large settlements and extensive trade networks. They often lived at the same sites which had been occupied in earlier times. Unlike earlier peoples, however, the Canaliño also settled in bottomlands and at the mouths of estuaries where they were occasionally threatened by floods. By the Late Prehistoric Period, these people had developed a specialized and highly diversified technology, including plank canoes for regular travel across the Santa Barbara Channel to island settlements. They used a diversity of materials for the manufacture of utensils, implements, housing and bodily ornamentations, many of which were made from marine or estuarine resources. Also of significance was the extensive use of asphalt to construct canoes and other items requiring waterproofing or adhesives. Terrestrial resources also continued to be important. Deer hunting was facilitated by the bow and arrow, newly introduced from the Great Basin. Plant foods, particularly storable seeds like acorn, wild cherry, grasses and sage, but also roots, tubers, bulbs and greens, helped to support the growing population. Both freshwater and salt marsh plants undoubtedly supplied a

variety of foods as has been noted for Goleta Slough (Brandoff, 1980). The Canaliño culture was the prehistoric equivalent of the coastal Chumash.

Several Late Period settlements occurred in the vicinity of Carpinteria Salt Marsh. Like their predecessors, the Canaliño were probably attracted by the following: the asphalt seep that surfaced east of Carpinteria Creek and freshwater springs in the same area; the extensive shellfish beds and the marine, estuarine and riverine fisheries of the region; and the many aquatic plants used for house thatching, basketry, and other items. Plant foods were available from nearby grassland, oak woodland, coastal scrub, chaparral, and riparian vegetation, in addition to those from the ocean and estuary. Topographically, both the mesa east of Carpinteria Creek and the sandspits and lowlands to the west and north provided suitable sites for villages. Thus, the region was ideal for settlement, as illustrated by the occurrence here of the most extensive Canaliño settlement between the mouth of Gaviota Creek and the Rincon, with the possible exception of the region of Goleta Slough (Rogers, 1929). The Carpinteria Creek village apparently extended from the estuary at the mouth of Carpinteria Creek, eastward along the ocean bluffs for about 3/4 mile, and northward from the beach also for about 3/4 mile (Rogers, 1929). This site was inhabited by the Chumash even after the first arrival of European man to the Carpinteria Valley, and in the historic period was first referred to as Misopsno (Mishopshno) by Font in 1776. This village was responsible for the current name of the area: the explorers observed plank canoes under construction and noted the area looked like a carpenter's shop, hence "Carpinteria." The population was estimated at over 300 at that time (Brown, 1967).

Other local Late Period settlements have been reported for the vicinity of Carpinteria Salt Marsh. West of the estuary and south of the existing polo field is a site that probably documents seasonal Canaliño use at an area known today as Serena. Additional sites have not been substantiated. For example, a location near the mouth of Toro Canyon may have been the site referred to as "kolok," although this was

unconfirmed by recent work (Wilcoxon, personal communication, 1985). Another location was reported to have occurred at the western end of the estuary, and was reportedly the site of "Teneknes" (Rogers, 1929). A reconsideration of the area has revealed that it was not the site of a prehistoric village (Wilcoxon, personal communication, 1985). "Teneknes" was apparently further upslope at the foot of the mountains or perhaps on the northern margin of the estuary (Timbrook, personal communication, 1985).

In summary, evidence found at archaeological sites of prehistoric inhabitants of Carpinteria Valley indicates that Carpinteria Salt Marsh was an important resource for food, shelter, basketry and implements. Many of these settlements also were located at the bases of foothills for some protection, and adjacent to freshwater springs that occurred at the margins of the estuary. Asphalt seeps near Carpinteria Creek also provided a valuable resource for use by inhabitants. Thus, conditions were favorable in the Carpinteria Valley and elsewhere on the South Coast for the evolution of the advanced culture of the Canaliño, later known as the Chumash. All prehistoric cultures apparently utilized the estuary to some degree, but probably had rather limited effects on the environmentally sensitive wetland system. While the extensive aboriginal settlements placed definite demands on local plants and animals used for food, implements and construction, these were renewable resources that suffered no apparent long-term adverse impacts.

HISTORIC PERIOD

Early Historic Period - Carpinteria Valley was occupied by the Barbareño Chumash Indians at the time of first contact with European culture. This group of Native Americans spoke a distinct language of the Chumashan linguistic family and occupied an area on the South Coast of Santa Barbara County from about Gaviota eastward to Punta Gorda. In 1542 Juan Rodriguez Cabrillo sailed up the Santa Barbara Channel and anchored off the coast of Carpinteria Valley, an area he described as

densely populated and having many oak groves. Sebastian Vizcaino apparently sailed past the Valley in 1602, and in 1769 Gaspar de Portolá and Father Juan Crespí traveled through the valley during the first Spanish expedition of the mainland and called the area "San Roque." Portolá claimed California for the king of Spain during this expedition. Crespí reported that one village in Carpinteria Valley had 38 huts and about 300 inhabitants. This village may have been "Mishopshno" as the Chumash called their main village. This also may have been the site referred to later by the Spanish as Puebla de la Carpinteria, a settlement located on the east bank at the mouth of Carpinteria Creek. This, too, was apparently the village documented by Cabrillo as "Misopsnow." Today the area is known as Concha Loma, a subdivision in the City of Carpinteria.

Following the establishment of a Mission in Santa Barbara in 1786, the Carpinteria Valley was granted to the Mission by the Spanish Government. Although many Chumash learned new skills and a new way of life from the Spanish, they lacked immunity to European diseases and many died. However, others resisted the mission system (e.g., the 1824 revolt) and others fled the area. After the ouster of Spanish rule in Mexico in 1822 and the formation of the Republic of Mexico, the Mission Pueblo Lands were secularized by the Mexican Government in 1834. Some Chumash continued to live on ranches in the Carpinteria Valley. After secularization, lands under Mission control were deeded to families loyal to the Mexican Government.

Middle Historic Period - Following the defeat of Mexico by the United States, California became a state in 1850. The U.S. Government formed a Land Commission to decide the validity of claims to land under Mexican deeds. In 1853 a map of Pueblo Lands of Santa Barbara was drawn up to establish ownership. Lands not confirmed to owners were opened for claims by Americans, and the remaining land was open to homesteading under the National Homestead Act of 1862.

During the second half of the 19th century and into the 20th century considerable impact, resulting from a combination of agricultural,

residential and industrial development, and climatic forces, has altered the configuration and natural resources of Carpinteria Salt Marsh. An early map of the estuary was produced by the U.S. Coast Survey in 1869 (Fig. 8). At this time Carpinteria Salt Marsh extended from the vicinity of Carpinteria Creek westward to beyond its present boundaries. A portion of the City of Carpinteria was eventually built on the eastern arm of the estuary, following destruction of wetlands by infilling.

The first historic settlement in the Valley was started on the northern margin of the estuary at the vicinity of Santa Monica Creek and Carpinteria Avenue. Although not shown on the 1869 map, in 1870 about 87 houses apparently existed in the area and about 427 people lived there. In 1875 a post office, grocery store, two saloons, a blacksmith shop, butcher shop, and many small dwellings were reported for the area. Edward Roberts reported in 1886 (Caldwell, 1979) that the village was adjacent to low salt marshes and drifted sand dunes that were fringed with reeds and willows.

A wharf and eventually a clubhouse were constructed at La Serena, west of the existing estuary on land bought by Milton Smith in 1863. Although another village might have developed here, the railroad reduced the need for a wharf at La Serena. Today, however, the area is dominated by residential development.

Early accounts of the Valley also revealed that some historic natural resources of the estuary are no longer present. For example, Stephen Olmstead noted in 1860 (Stockton, 1960) that quantities of oysters occurred at the mouth of Franklin Creek. But between 1860 and 1870 there were many storms that caused significant erosion in the foothills and upper valley. According to this account high tides flooded the estuary and the vicinity of the village and "ruined" the oyster beds. A more plausible explanation is that excessive deposition of eroded sediments buried the beds. Of note is the observation that oyster shells are among the faunal remains present in middens of the area, indicating their use by earlier cultures (Wilcoxon, 1982). In

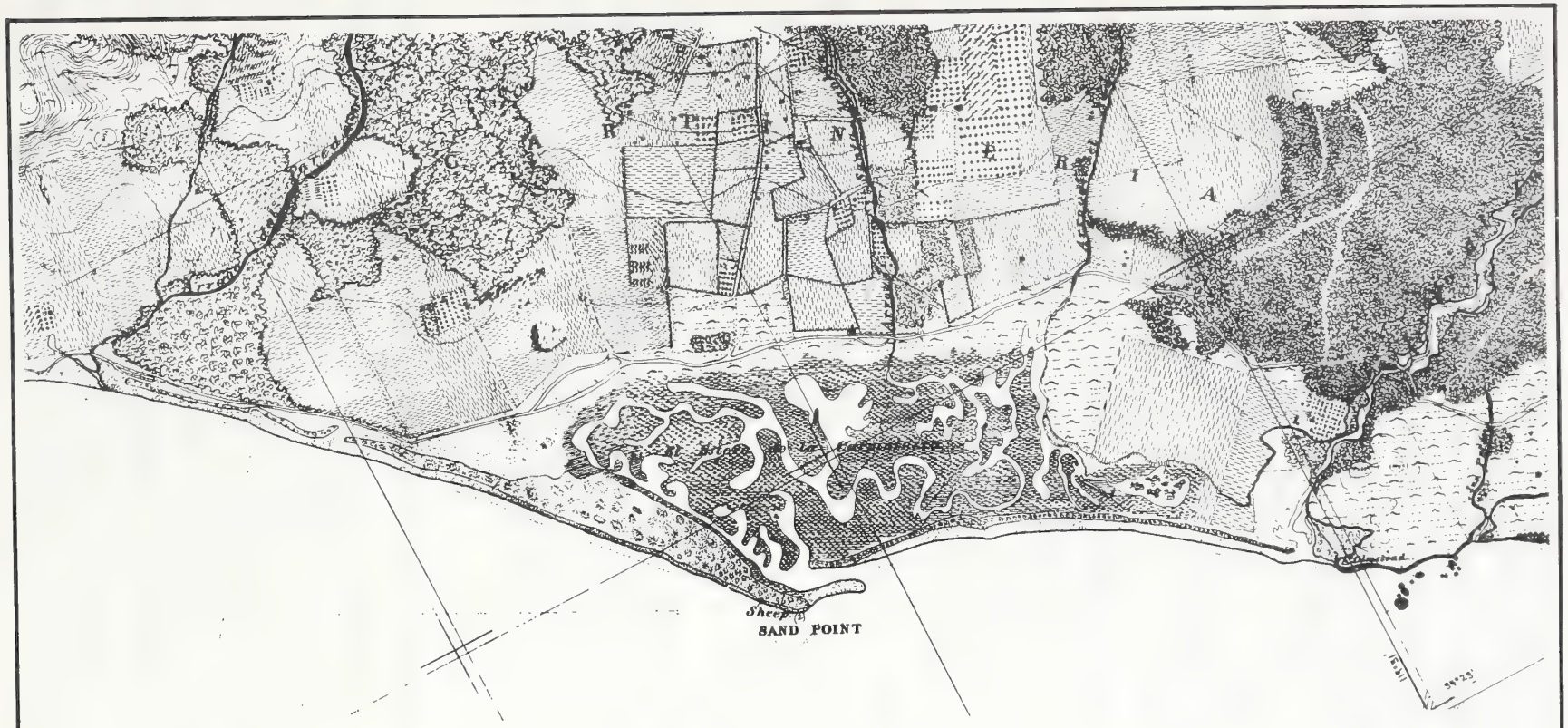


Fig. 8. CARPINTERIA SALT MARSH AND VICINITY, 1869. This map was prepared by the United States Coast Survey as part of a series of maps of the western coast of the United States. Several observations of significance include the following: the eastern arm of the estuary extending almost to Carpinteria Creek; the drainage of Franklin and Santa Monica Creeks into the estuary; the location on the northern margin of the estuary of a road that eventually became Carpinteria Avenue; the extensive oak woodland along Carpinteria Creek and other woodlands in the area; the dune system near Sand Point; the grasslands adjacent to estuarine wetlands; and the extensive agricultural development of the upland surrounding Carpintera Salt Marsh.

addition to the destruction of oyster beds, several local streams, particularly that in Arroyo Parida, reportedly changed their courses during this period of storms. Thus, natural forces have played an important role in the alteration of the estuarine ecosystem. It should be noted, however, that extensive agricultural development was present on the alluvial plains surrounding Carpinteria Salt Marsh even at this early date. This situation could have caused increased siltation due to the erosion of exposed and tilled soils, and because of the apparent lack of any system to prevent this erosion or to direct runoff.

As noted in the discussion of the geologic history of Carpinteria Valley, infilling of the estuary has been an ongoing process associated with erosion of the uplands. However, even 120 years ago increased sediment loads in streams during storm conditions, caused by human activities, could have increased the rate of siltation over natural levels in the basin. If the rate of sedimentation exceeds that of subsidence, then eventually Carpinteria Salt Marsh would be converted from wetland to upland habitats. Various authors cited above suggest extended boundaries for Carpinteria Salt Marsh during the previous century. The estuary is commonly thought to have extended to the vicinity of Foothill Road, westward to the area of the current polo fields, and eastward to Carpinteria Creek. Clark (1962) suggests it covered three quarters of the valley at one time. Thus, the present estuary may be less than half the size it was during early historic time.

Two early transportation arteries also have had significant impacts on Carpinteria Salt Marsh. The first road through Carpinteria Valley (Fig. 8) was constructed to provide a route for stage coach travel between Santa Barbara and Los Angeles. Soil from Ortega Hill was used to build a berm through wetlands along the northern portion of the estuary, from an area known today as Santa Claus Lane eastward to Carpinteria Creek. Similarly, construction of the Southern Pacific Railroad through the Carpinteria Valley also affected the estuary. When the railroad was being built in 1884, a temporary track was laid westward from Rincon Point to transport fill material to make a berm to

support the new track. This berm was placed in the estuary just south of the stagecoach road. The construction of two nearby parallel arteries through wetlands resulted in the elimination of habitats and the disruption of circulation patterns. These impacts affected the entire northern margin of the estuary and eventually led to the infilling and destruction of nearly all northern high and transitional marsh habitats.

The first train to travel through to Santa Barbara came on August 19, 1887. Because the station for Carpinteria was built on Linden Avenue east of the existing village, the center of business activity and construction moved eastward. The original village was referred to as "Old Town", a name that is still used today. By 1888 Carpinteria Valley had a population of about 800 (Caldwell, 1979).

In addition to the activities described previously, other developments and phenomena also changed the nature of Carpinteria Salt Marsh. For example, as agricultural, commercial, and residential development increased in the town of Carpinteria, wetlands adjacent to development became obvious areas for expansion. One successful method of draining the wetlands was implemented by Edwin P. Sawyer in 1878, on land owned by his son along Linden Avenue (Stockton, 1960; Caldwell, 1982). He used "ground tiles" to make drainage lines directed into Santa Monica [Franklin?] Creek. "Ponds" occurring in the area and along the drainage lines apparently supported many frogs, birds, and cattails, thus suggesting significant amounts of impounded fresh or brackish water. Some of the ponded areas were used around the turn of the century in an unsuccessful attempt to raise turtles commercially for food. The Sawyers eventually had to start their own factory to make enough tiles to drain their property. Over a period of several years this portion of wetland drained and dried. Other property owners impressed with this method of marsh "reclamation" drained additional portions of the estuary early in the 20th century, and by 1913 (Caldwell, 1982) some of the land had been planted with beans. According to Stockton (1960) some time after the Sawyers built their factory, "...L.B. Caldwell tiled lowlands on lower Santa Monica Creek Road and others followed the practice,

beginning one of the major changes in the valley and reducing the slough from its extent across the valley floor to its present tidelands."

Late Historic Period - In January, 1914, a major storm hit the South Coast of Santa Barbara County, and not only caused extensive damage to areas such as "Old Town," but also altered the wetlands of Carpinteria Salt Marsh. Significant amounts of erosion in local watersheds, particularly that of Santa Monica Creek, resulted in the spread of silt and mud over the lowlands and deposited as much as two feet of material across portions of the estuary. Also, sand dunes at the beach had been practically wasted away (Clark, 1962). In spite of the damage caused by the storm, general local opinion was apparently that of gratitude, because various lowlands and estuarine wetlands had been transformed into farmland (Stockton, 1960; Caldwell, 1982).

Several additional events of the first quarter of the 20th century demonstrate the continued use of and impact to the estuary; however, others illustrate an awareness of the environmental value of this ecosystem. In 1910, Joel Remington Fithian and Stewart Edward White purchased Carpinteria Salt Marsh and the sandspits along the southern margin of it (Clark, 1962; Spaulding, 1962). White built "...a modest beach house on the farmland between the southern edge of the marsh and the beginning of the verbena and primrose covered dunes strip..." (Spaulding, 1962); and this area, that he called "Sandyland", became a favorite recreation beach for his associates. Although White was quite interested in the natural history of the area, it was not until William Leon Dawson began visiting the estuary that the significance of its natural resources became known. Dawson was a noted ornithologist who photographed many of the birds of Carpinteria Salt Marsh and included some of them in his important work, BIRDS OF CALIFORNIA. Also of note was his collection of bird eggs, once located in his Mission Canyon home and to which he gave the name "The Museum of Comparative Oology." This collection was the predecessor of the present Santa Barbara Museum of Natural History.

In 1915 White sold a portion of the dunes and marsh behind them, and this property was subdivided and sold to various South Coast families. By 1917 beach "cottages" were built upon a few of the lots resulting in destruction of some dune habitat.

The popularity of Sandyland continued to increase over the years. The largest house (Casa Blanca) built at Sandyland was that constructed in about 1928 for Mr. Albert Isham at the western end of the estuary. The Carpinteria beaches also continued to be popular bathing sites, and with increased availability of automobiles more people came to the area for recreation. Temporary camps were set up both west of Sandyland in the vicinity of Serena and east of the cottages towards the end of Linden Avenue. Impacts to dune and estuarine habitats in this area are evident in a photograph (Fig. 9a) from this period. However, also evident is an extensive dune system, vegetated by native plants, and the eastern arm of the estuary. Additional aspects of Carpinteria Salt Marsh and the surrounding watershed are illustrated for this period in a photograph (Fig. 9b) taken in 1924.

Demand for beach front property was such that additional subdivisions of the region were developed. A "Sandyland Dunes" development was built west of the estuary in the vicinity of Serena, and a "Sandyland Cove" section was developed east of the mouth of the estuary toward Carpinteria. Eventually the Sandyland Protective Association was formed by residents who lived on the sandspit west of the mouth of the estuary, and a similar group (Sandyland Cove Trust) formed at Sandyland Cove. This action resulted in restricted access to the dune areas and to the associated wetlands. Because of the appreciation for the many natural resources of Carpinteria Salt Marsh by members of these associations, the estuary has been protected from many impacts.

The second quarter of the 20th Century began with a major event west of the Carpinteria Valley that would have a profound effect on the coastline of the region. In 1927, construction began on a breakwater for a marina at Santa Barbara (Penfield, 1960). This resulted in the disruption of the migration of sand along the coast, causing erosion of



Fig. 9a. CARPINTERIA SALT MARSH (early 1900's): View from near foot of Linden Avenue, northwestward along sand dunes and eastern arm of the estuary. Note beach vegetation, extent of estuary and location of the camp in habitats transitional between dune and wetland systems. Today this area is covered by the southern portion of the City of Carpinteria. Photograph from the Carpinteria Valley Museum of History.



Fig. 9b. CARPINTERIA SALT MARSH (1924): View from high marsh area along dune system, northward across eastern arm of estuary toward the Santa Ynez Mountains. Note absence of shrubs along northern margin of wetland and the extensive low marsh that is covered by development today. Photograph from the Carpinteria Valley Museum of History.

sand beaches east of the breakwater (Penfield, 1960; Bailand/Jenkins, 1982). Thus, extensive beach loss occurred from East Beach in Santa Barbara eastward eventually to Sandyland and Carpinteria. A number of the homes at "Sandyland Dunes" and Sandyland were lost to receding shorelines, while others were moved further inland for protection. The estuary was not impacted obviously by this event (Spaulding, 1962); however, erosion of the dunes may have contributed to an increase in deposition of sand in the mouth of the estuary, causing it to close for long periods. A seawall or revetment was finally constructed at Sandyland in 1964 (Rouse, 1982) to prevent further erosion of the coast, to protect the homes that occurred on the narrow sandspit, and to provide an open mouth of the estuary.

Aerial photographs (Fig. 10a-f) for nearly a 50-year period (1932-1981) illustrate some of the many impacts to and changes in the estuarine wetlands of Carpinteria Salt Marsh and the uplands immediately adjacent to them. In 1932 (Fig. 10a), Carpinteria Salt Marsh covered a larger area than today and extended eastward to and beyond Linden Avenue, the southern extension of which occurs in the far right center of the photograph. Two additional roads extended from Carpinteria southward across the wetland. These do not occur in a 1929 aerial photograph not shown here. The western-most road (Ash Avenue) forms the eastern boundary of the estuarine system today. Also of note are the following: short linear ditches throughout much of the central portion of the marsh, apparently made as an early attempt to drain the marsh or to improve circulation; an extensive, partially vegetated alluvial fan and associated salt flat at the mouth of Santa Monica Creek that probably resulted at least in part from the erosion caused by storms in 1914, as discussed previously; "Old Town" located in the north central portion of the photograph, north of the Southern Pacific Railroad and largely south of Carpinteria Avenue; access roads along and houses on the sandspit of Sandyland Cove to the east of the mouth of the estuary, and on the sandspit of Sandyland west of the mouth of the estuary; and agricultural development in upland north of Carpinteria Avenue. Sand Point, the eastern extension of Sandyland at the mouth of the estuary is not evident, although illustrated on the 1869 map by U. S. Coast Survey

10a. 1932.



10b. 1943.

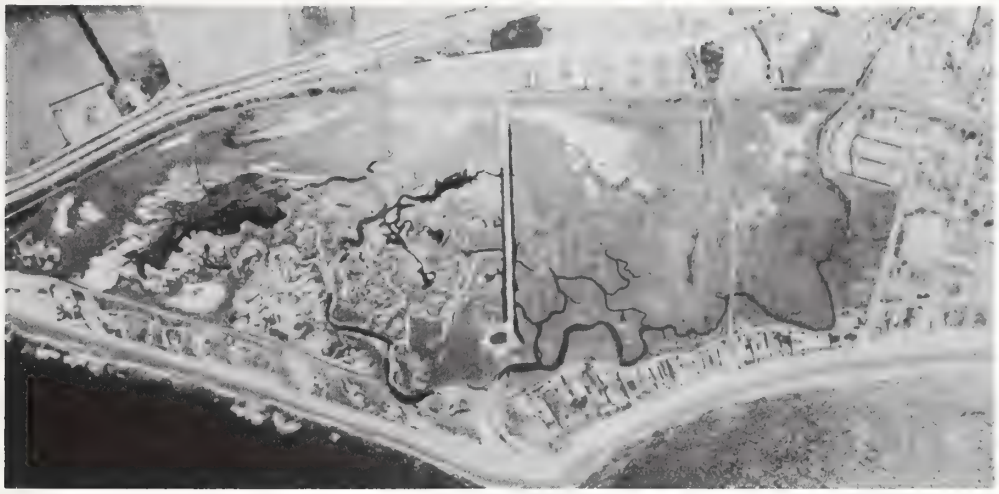


10c. 1947.



Fig. 10a-c. CARPINTERIA SALT MARSH: 1932-1947.

10d. 1961.



10e. 1967.



10f. 1981.



Fig. 10d-f. CARPINTERIA SALT MARSH: 1961-1981.

(Fig. 8). This feature was apparently present and not covered by high tides until about 1925, after which time it may have disappeared as a result of coastline changes following the 1925 earthquake (Clark, 1962), or from erosion following the construction of the Santa Barbara Harbor in 1926.

By 1943 (Fig. 10b), other coastline changes can be noted, particularly the increased erosion along Sandyland. Several building sites that were once behind dunes (Fig. 10a) were clearly beach front by this date. Spaulding (1962) has indicated that little activity occurred at the site during World War II because of the shortage of gasoline, and that during this period, "...Sandyland was all but deserted." However, activity apparently returned by 1947 (Fig. 10c), evidenced by road repairs and additional building at Sandyland Cove. Other more striking alterations include the following: construction of Apple Road and adjacent drainage ditches southward from Carpinteria Avenue into the center of the marsh for access to an exploratory oil well; the infilling of much of the eastern arm of the estuary; and the channelization of Santa Monica Creek across the alluvial fan to a tidal channel.

Additional encroachment into wetlands is visible in an aerial photograph from 1961 (Fig. 10d). A new route for an access road (Sand Point Road) to properties at Sandyland was built across salt marsh habitat, thereby increasing the area where building could occur between the dunes and the new road. Portions of the old road were still evident by this date, and an earlier photograph not shown here demonstrates that the newer road was constructed after 1954. Furthermore, removal of sand from an area of high marsh north of the Sand Point Road, evident in the photograph, was apparently used to construct a berm for the new road. This action was a serious although unrealized impact to the high marsh habitat now rare at Carpinteria Salt Marsh. Also to be noted are the following: the increase in development of Sandyland Cove and the City of Carpinteria; the construction of U. S. Highway 101 with a parallel access road north of Carpinteria Avenue; the excavation of channels to connect Franklin and Santa Monica Creeks to tidal channels; and the infilling of wetland east of Ash Avenue in Carpinteria.

Prior to 1967 (Fig. 10e) several events had major long-term effects in the wetland and dune systems. The most significant of these were the channelization of Franklin and Santa Monica Creeks in 1966, clearly evident in the photograph. Previous photographs (Fig. 10a-d) indicate natural or modified drainage of the creeks into or through the marsh. Channelization and berm construction resulted in further partitioning of the estuary, the alteration of natural drainage patterns, and the loss of marsh habitat. However, a more permanent route from the streams to the mouth of the estuary also may have kept the estuary open to the ocean for longer periods by increasing the tidal prism. Other impacts or changes included the following: construction of a seawall along Sandyland and at the inlet; filling of wetland west of Ash Avenue; and the expansion of a forested wetland along the western portion of the northern margin of the estuary.

Perhaps the most important phenomenon documented by this sequence of aerial photographs is the dynamics of vegetation covering the tidal mud flats of Carpinteria Salt Marsh. Note in 1967 (Fig. 10e) that much of the marsh dominated previously by vegetation, largely Salicornia virginica (Pickleweed), occurs as nonvegetated mud flat. This loss of vegetation may have been initiated before 1961 (Fig. 10d), but clearly was not evident in 1947 (Fig. 10c).

The channelization of streams may be directly related to vegetation change. As reported by Caldwell (1982), Mr. James Stubchaer, Santa Barbara County Flood Control District, has stated that, "Before 1966 there was no flushing in the estero. It was stagnant with no opening to the ocean. Today the outlet to the ocean stays open naturally." Although some flushing did take place, as illustrated by the aerial photographs (Fig. 10a-e), marsh closure apparently did occur at least seasonally from 1938 to 1966 (USDA Soil Conservation Service, 1983). The channelization of streams and placement of revetment at the mouth of the estuary restored or enhanced tidal circulation within the estuary, and by 1981 (Fig. 10f) Pickleweed again covered most of the western portion of the marsh except for tidal channels and the original mud

flat. A more detailed discussion of this phenomenon occurs in the section BOTANICAL RESOURCES: Disturbance and Vegetation Change.

In 1971, a large fire, referred to as the Romero Fire, occurred in the Carpinteria Watershed. Storms in December of that year caused extensive erosion and resulted in severe flooding of the Carpinteria Valley. Peak flow in Carpinteria Creek was measured at 8000 cubic/feet/second (cfs), significantly above that of many other flood rates (e.g., 2720 cfs in 1966; 4560 cfs in 1969; 2000 cfs in 1980) (USGS, 1967, 1969, 1971, 1980). Sediment was deposited in the estuary and Santa Monica Creek had to be dredged. This creek was dredged again in 1974, from the Southern Pacific Railroad south to the confluence with Franklin Creek. Dredging also occurred from the confluence of the creeks downstream to about Apple Road.

Additional channelization occurred along Franklin and Santa Monica Creeks in 1979 and is evident in an aerial photograph from 1981 (Fig. 10f). New berms constructed along the channelized portions of these creeks during the 1970s further restricted tidal circulation. This impact was most acute in the basin east of Sandyland Cove Road, where most wetland receives only rain water and no tidal circulation. Of further interest in this photograph is the illustration of excessive amounts of sediment at the junction of the western confluence of Franklin and Santa Monica Creeks and the mouth of the estuary. Sediment deposited here apparently exceeds that illustrated in all other photographs and also extends westward in a tidal channel further than in previous decades. This potentially serious situation may have resulted from increased sediment transport in the channelized creeks or from increased sediment deposition from incoming tides. Maintenance dredging at this site is necessary to prevent possible closure of the mouth of the estuary. However, the mouth was blocked by a sandbar in 1982, but reopened by the Santa Barbara County Flood Control District. Other impacts to the vicinity of Carpinteria Salt Marsh during this period include the following: commercial (greenhouses) and residential development of watershed areas north of U. S. Highway 101; additional construction at Sandyland and Sandyland Cove; use of alluvial fan areas, berms, and sandspits of the mouth of the estuary for temporary storage

and draining of dredge spoil; and the reexcavation of drainage ditches along and into the northwestern margin of the estuary.

The State of California acquired property east of Linden Avenue in 1932 and created Carpinteria State Beach Park on land previously part of and adjacent to Carpinteria Salt Marsh. The Park was relatively undeveloped until the 1960's, and when the City of Carpinteria incorporated in 1965, portions of several streets were abandoned at the request of the State to enhance the Park (City of Carpinteria, 1980). Today the Park extends eastward beyond the estuary of Carpinteria Creek. Proposals for additional expansion include property on the east bank of Carpinteria Creek containing riparian habitats. Sensitive biological, archaelogical, and paleontological resources of the State Park are discussed in the Carpinteria State Beach Park Proposed Master Plan.

CARPINTERIA SALT MARSH RESERVE

The University of California Natural Reserve System (NRS) celebrates its 20th Anniversary in 1985. During formation of the NRS and consideration of sites for potential reserves, Kenneth S. Norris, then a Professor of Zoology at UC Santa Cruz, identified Carpinteria Salt Marsh as an important coastal wetland system that was already utilized as a study area for students at UCSB. The estuary was also among those sites suggested by Carl L. Hubbs, Professor of Biology at Scripps Institution of Oceanography, as having a long range potential for acquisition by the University. In correspondence with the California Department of Fish and Game (DFG) in 1967, Dr. Norris expressed hope that the University might obtain ownership of Carpinteria Salt Marsh and that mutually useful plans for the area might be developed by both agencies. The DFG was also interested in acquiring the marsh to make it an ecological reserve.

An informal survey of UCSB biologists in 1969 resulted in a vigorous affirmation of the great value of the salt marsh as an outdoor

laboratory for students. By December of that year J. Robert Haller, Associate Professor of Botany at UCSB, had prepared a proposal for a natural reserve at "Sandyland Marsh." Haller emphasized that, "The marsh of Sandyland is one of the few remaining salt water marshes along the coast of southern California; its scientific value is especially great because of its relatively undisturbed condition. The marsh supports many species of plants and animals that occur in no other habitat... The Sandyland Marsh has been used for many years as an observation and research area by naturalists and scientists... This kind of use would continue, and, in our opinion, would be enhanced by bringing the marsh into the University's [Natural Reserve System], since the system was established specifically to preserve the long-term natural values of the lands under its jurisdiction. The proposed reserve would be administered by a committee of environmentalists from the UCSB campus, that would restrict permission to use the reserve to qualified persons or agencies."

The Sandyland Cove Trust, originally a consortium of 10 home owners at Sandyland Cove, owned a portion of the estuary and was willing to sell the property to The University at a price significantly below fair market value. They also had been given an offer by a developer who wanted to turn the wetland into a marina. The Regents of the University of California allocated $100,000 in 1970 to match an equal amount provided by a grant from the Ford Foundation, and this sum was offered for the purchase of 120 acres. The balance of the appraised value of the property represented a gift to the University by the Sandyland Cove Trust.

Following various delays in negotiations, the final acquisition of the 120 acres occurred in June, 1977, when the property was transferred to the University of California. The Sandyland Cove Trust retains ownership of the remaining wetlands eastward to the Carpinteria City Limit and a small buffer area along the northern margin of Sandyland Cove. The Sandyland Protective Association, a consortium of homeowners having residences at Sandyland, owns 38 acres of wetland west of the

University property. Additional aspects of ownership have been discussed by Macdonald (1976).

Carpinteria Salt Marsh Reserve (Fig. 2) was the 23rd reserve added to the NRS. Today it is the focal point for various research and teaching projects, as documented in annual reports published by the NRS. Permission to visit the Reserve for research and teaching activities can be obtained by filing an application with the NRS office of the Marine Science Institute at UCSB.

STATUS

Carpinteria Salt Marsh is located within the Carpinteria Valley Planning Area of the Santa Barbara County Coastal Plan, and is the largest coastal wetland under County jurisdiction (County of Santa Barbara, 1982). In the Coastal Plan, it was given the status of "environmentally sensitive habitat area," defined in the California Coastal Act (State of California, 1976) as "...any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed as degraded by human activities and developments." This designation is adequate to protect the estuary from direct threat of development, but indirect impacts such as sedimentation, toxic runoff, and effects from land use practices in the watershed can threaten its biological productivity (County of Santa Barbara, 1982).

In the Santa Barbara County Coastal Plan, policies were adopted to minimize alteration of watershed areas and to protect wetlands. Policies affecting Carpinteria Salt Marsh include, for example, the following: 1) dredging is permitted for the maintenance of tidal flow and continued viability of the wetland habitat or for flood control purposes, but is subject to various conditions such as size of area, time of year, design specifications, etc.; 2) dredge spoils shall not be deposited permanently in areas subject to tidal influence; 3) boating shall be prohibited in wetlands except for research or maintenance

purposes; 4) a buffer strip of at least 100 feet shall be maintained in natural condition along the periphery of wetlands; 5) light recreation such as birdwatching and scientific or educational uses is permitted; 6) wetland sandbars may be dredged for the maintenance of tidal flow to ensure the continued biological productivity of the wetland; 7) no unauthorized vehicle traffic shall be permitted and pedestrian traffic shall be regulated; 8) new development adjacent to or in close proximity to wetlands shall be compatible with the continuance of the habitat area and shall not result in a reduction in the biological productivity or water quality of the wetland due to runoff or other disturbances; 9) no grazing or other agricultural uses shall be permitted in coastal wetlands; and 10) mosquito abatement practices shall be limited to the minimum necessary to protect health of area residents and to prevent damage to natural resources.

Specific to Carpinteria Salt Marsh, the Coastal Plan indicates the County of Santa Barbara "...shall request the Department of Fish and Game to identify the extent of degradation which has occurred in the Carpinteria Estero...[and] As part of the study, the Department, working jointly with the Santa Barbara County Flood Control Department and the Soil Conservation Service, will also identify the most feasible means of restoration and the area of wetlands to be restored." Thus, policies of Santa Barbara County recognize the biological value of Carpinteria Salt Marsh, provide protection for the habitats, and propose restoration of wetlands.

Because the City of Carpinteria occurs adjacent to and includes a small portion of Carpinteria Salt Marsh, the City of Carpinteria Coastal Plan (City of Carpinteria, 1980) also addresses the environmentally sensitive nature of the habitats. Likewise, the estuary of Carpinteria Creek is designated an environmentally sensitive habitat area. Policies similar to those of the County have been adopted and additional ones specific to the City are listed in the Coastal Plan. These include for example, the following: 1) the City shall prepare an implementation program for the development of Carpinteria, Santa Monica, and Franklin creek trails; 2) the creek trails shall be designed and located to

prevent any direct or indirect impacts on the riparian habitats of the creeks or on Carpinteria Salt Marsh; 3) a feasibility study for a proposed recreation pier and related facilities should be conducted and should include an assessment of impacts on Carpinteria Salt Marsh; 4) the City shall pursue available funding sources to determine the extent to which the area bounded by Ash Avenue, Third Street, and the City's western boundary may be reasonably restored as a tidal marsh and to what extent this area lies within public trust; and 5) several additional policies pertaining to the specific plan for development that might occur along Ash Avenue. Policies concerning dune and strand habitats also are listed in both coastal plans.

The high status for environmental value given Carpinteria Salt Marsh in many documents is related to the important biological and physical value of coastal wetlands as a whole, and for the particular value of Carpinteria Salt Marsh for biological resources such as federally listed endangered species. These resources include two birds (Light-Footed Clapper Rail and Belding's Savanna Sparrow) that nest there, and one plant (Salt Marsh Bird's-Beak). Additional endangered birds (Brown Pelican and California Least Tern), a bird of special concern (Osprey), and many regionally rare plants also are recorded for the estuary. The California Department of Fish and Game (Bauer and Speth, 1974) listed Carpinteria Salt Marsh as a high priority wetland for protection because of this resource value. Thus at the Federal (e.g., Endangered Species Act, and lists such as USDI, 1980), State (e.g., Designated Endangered Plants, and California Coastal Act), and local (e.g., Coastal Plans) levels, Carpinteria Salt Marsh has been recognized for its environmental quality and special nature, and is protected by policies adopted at all levels.

SUMMARY

The history of Carpinteria Valley covers more than 7,000 years of habitation during which Carpinteria Salt Marsh has had a significant influence on the lives of many residents. The eventual urbanization of the Carpinteria Valley has had a tremendous impact on the natural resoures of the estuary. Three cultural divisions have been suggested for the prehistoric periods of the region. Archaeological evidence indicates that prehistoric inhabitants utilized the resources of Carpinteria Salt Marsh for food, shelter, basketry, and implements. All prehistoric cultures of the region apparently depended on the estuary to some degree, but probably did not adversely affect the environmentally sensitive wetlands.

During the historic period the first settlement in the Valley occurred on the margin of Carpinteria Salt Marsh at the mouth of Santa Monica Creek. The construction of a stagecoach road, railroad, and the diking, draining, and filling of wetlands all contributed to the reduction of the size of the estuary. A catastrophic flood in 1914 resulted in the deposition of a large alluvial fan in Carpinteria Salt Marsh. Additional construction of roads that traversed the wetlands, development on the adjacent sand spits, and erosion of the coastline following the construction of the Santa Barbara Harbor all contributed to the reduction or alteration of habitats. The closing of the mouth of the estuary led to long-term flooding of the low marsh and eventual death of extensive salt marsh vegetation. Because of this lack of tidal circulation and the occurrence of additional flooding in the Valley, stream courses were channelized through the estuary to permit runoff to flow unimpeded to the ocean, and to improve the health of the marsh by restoring tidal inundation of wetlands.

Several other events have had beneficial effects on the estuary. In 1977, Carpinteria Salt Marsh Reserve, an ecological reserve owned and managed by the University of California, was established on property obtained from the Sandyland Cove Trust. Carpinteria Salt Marsh was the

23rd reserve added to the UC Natural Reserve System and today is the focal point for various research and teaching projects. Additionally, recognition of the value of coastal wetlands in legislation, such as the California Coast Act of 1976, and in policies of the County of Santa Barbara and the City of Carpinteria Coastal Plans, provides protection for the remaining wetlands at Carpinteria Salt Marsh.

BOTANICAL RESOURCES



HABITATS

VEGETATION

DISTURBANCE & VEGETATION CHANGE

FLORA

B O T A N I C A L R E S O U R C E S

The botanical resources investigated during this study include all plant associations and plant taxa identified not only from the principal study area (Carpinteria Salt Marsh) but also from adjacent sites that support related vegetation, from the estuary and lower riparian corridor along Carpinteria Creek, and from the historical wetland or dune habitats that have been destroyed during development of the region. A delineation of the study area and the extent of historic habitats have been presented in the sections entitled INTRODUCTION: Methods, and HISTORY, respectively.

HABITATS

The term "habitat" as used herein is defined as an area having a certain combination of physical and/or biological attributes that result in the area supporting a distinctive association of plants at a particular point in time. Plant habitats at Carpinteria Salt Marsh are influenced by a wide variety of factors including, for example, topographic relief, water regime, salinity, substrate, density and seasonality of vegetation, climate and weather, and disturbance. Associated with these factors is the relationship between habitat characteristics and both long-term (e.g., geological) and short-term (e.g., seasonal) changes that take place at the estuary. Long term changes have included, for example, subsidence of the basin, changes in sea level, deposition of alluvial fans, loss of wetland to development, and alteration of stream patterns that drain or have drained into or through the estuary. Short term changes include annual climatic fluctuations, dry versus wet years, and the opening or closing of the mouth of the estuary. Changes in the vegetation and flora of the study area have been in response to the various long-term and short-term changes in the habitats, thus illustrating the dynamic aspects of the estuarine system.

Classification of the vegetation of Carpinteria Salt Marsh (Appendices I and II) is based in part on the classification of habitats occurring there. A primary distinction includes the separation of wetland from upland types. "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purposes of this classification, wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; (3) the substrate is nonsoil and is saturated with water or covered by shallow water at sometime during the growing season of each year (Cowardin et al., 1979)." All other habitats are upland types, or transitional types not easily grouped into one or the other. Transitional types often occur at disturbed sites around the margins of estuaries.

Upland habitats at Carpinteria Salt Marsh and vicinity (Fig. 11, in part) include natural types such as dunes and the higher elevations of alluvial fans, and man-made types such as berms (slopes and tops), roadsides, railroad banks, dredge spoil and debris piles, and gardens. These habitats can be grouped further into vegetated and nonvegetated types, and undisturbed, recently disturbed, and historically disturbed types. Other aspects of upland habitats affecting plants include the nature of the substrate, such as its composition (e.g., sandy or clayey), origin (e.g., streambed or estuarine marsh), permeability (e.g., well-drained or poorly-drained), salinity (e.g., nonsaline, partially leached, saline), and the topographic relief of the habitat feature (e.g., degree of slope).

Wetland habitats (Figs. 11, 12) include numerous intertidal, subtidal, and nontidal types, and vegetated and nonvegetated types. The habitats can be grouped into 4 systems of wetland types (Cowardin et al., 1979) that exist currently or have existed historically in or adjacent to Carpinteria Salt Marsh. The Estuarine System includes wetlands commonly referred to as salt marshes, and consists of subtidal and intertidal wetlands usually confined to coastal embayments or other



Fig. 11. HABITATS: View northeastward along recently deposited dredge spoil and a graded berm along Santa Monica Creek. Partially vegetated salt flats resulting from scraped spoil piles occur west of the berm and are dominated by *Salicornia virginica*. Vegetated alluvial fan deposits occur to the left center.



Fig. 12. HABITATS: View northwestward along tidal channel and over regularly flooded mud flats dominated by *Salicornia virginica*, toward Apple Road, a low berm that is dominated by plants characteristic of high marsh habitats.

physiographic features that are at some point during the year open to the ocean, receive freshwater runoff, and are flooded by water with an average annual low flow salinity greater than 0.5°/oo from ocean derived salts. The following are vegetated and nonvegetated estuarine habitats at Carpinteria Salt Marsh: subtidal and intertidal channelized streambeds and natural drainage channels; mud, sand and salt flats; low berms and sandbars; unobstructed marshland as well as partially or completely diked areas; channel and berm banks; and low elevations of alluvial fans. Habitats vegetated by vascular plants are restricted to the intertidal areas; although some intertidal habitats such as barren flats also remain unvegetated, apparently because of excessive flooding (mud flats), or because of irregular flooding and evaporation (salt flats) that results in an accumulation of salt preventing the growth of vegetation.

The Palustrine System includes wetlands that are characterized by persistent plant types when vegetated (or if nonpersistent vegetation occurs the habitat is not a riverbed or streambed), and that are flooded by water with an average annual salinity less than 0.5°/oo from ocean-derived salts. The following are palustrine habitats at Carpinteria Salt Marsh: freshwater ditches and northern margins of the estuary adjacent to areas of runoff; diked salt marsh that no longer receives tidal flooding; and saline vernal depressions on berms and other disturbed, nontidal substrates.

Two other systems of wetlands occur adjacent to Carpinteria Salt Marsh. The Riverine System occurs upstream on Franklin and Santa Monica Creeks beyond the limits of the study area (cement-lined along lower limits) and on Carpinteria Creek above the estuary. Riverine habitats occur in highly-altered habitats such as river or streambeds that are characterized by nonpersistent plant types when vegetated, and are flooded by water with an average annual low flow salinity less than 0.5°/oo from ocean-derived salts. The Marine System occurs seaward of the sandspits and south of the mouth of the estuary, and includes subtidal and intertidal habitats overlying the continental shelf and its coastline where salinities usually exceed 30°/oo.

VEGETATION

The emergent vegetation of estuaries of southern California has been discussed in general by several authors (e.g., Macdonald and Barbour, 1974; Henrickson, 1976; Macdonald, 1977; Zedler, 1982). Other investigators have reported on the vegetation of particular estuaries such as Upper Newport Bay (Vogl, 1966), the Tijuana Estuary (Zedler, 1977) and Goleta Slough (Ferren and Rindlaub, 1983). Various methods have been employed by these authors to describe the vegetation and to analyze vegetation dynamics for these estuaries. For the present study, the vegetation of Carpinteria Salt Marsh was classified (Appendices I, II) using modified schemes by Cheatham and Haller (1975) for uplands and Cowardin et al. (1979) for wetlands, and was mapped (Figs. 13, 14) using aerial photographs associated with extensive field work. Aspects of the various units of vegetation are reported below. More complete species lists are located in Appendices I and II, and infraspecific taxa are included in the Annotated and Illustrated Catalogue (Appendix III).

Upland Vegetation

The majority of the upland vegetation in the vicinity of Carpinteria Salt Marsh is highly disturbed, often transition to wetland vegetation, and occurs as a result of the modifications of the estuary and Carpinteria Valley by various forms of development. However, native dune, grassland, and scrub communities can be interpreted from historic information and from remnants of this vegetation.

Disturbed Coastal Habitat Vegetation - This unit of vegetation includes a variety of plant associations that are dominated largely by ruderal herbaceous species, that usually occur on disturbed substrates, and at a particular point in time apparently reflect the nature of the substrate (e.g., saline, leached, compacted) and the length of time

Fig. 13. VEGETATION MAP OF CARPINTERIA SALT MARSH

LEGEND

Vegetation or habitat classifications terminology is based in part on Cheatham & Haller (1975) for upland, Cowardin et al. (1979) for wetland. Dominate or characteristic genera or species are listed for most vegetated areas but not all species listed are found at all sites. Refer to Appendix 1 and 2 for a more thorough classification of the vegetation and for a complete species list.

UPLAND

Non-Vegetated

- flats and berm crests

Cultivated

- Myoporum/mixed exotics
- Carpobrotus
- gardens

Disturbed Coastal Habitat

Herbaceous Vegetation

- roadsides, berm crests and margins, dredge spoil
- Disturbed Coastal Habitat/Palustrine Wetland transition

Herbaceous and other plants

- debris pile (Arundo, Yucca, Opuntia)

Grassland

- + + + Cismontane introduced Grasses

Coastal Scrub

- Artemisia, Baccharis, Isocoma on alluvial fan deposits; scattered individuals of Salix, Malacothamnus and Myoporum etc.

WETLAND

Estuarine Wetland

Non-Vegetated (various water regimes)

- channels
- mud flats (M) and exposed channels, salt flats (SF), sand flats (SD), dredge spoil and scraped flats.

Vegetated

Emergent Wetland

Irregularly Exposed Wetland

- Scirpus maritimus (Typha domingensis)

Regularly Flooded Wetland

Low Marsh

- Salicornia virginica

Irregularly Flooded Wetland

Middle Marsh

- Apium, Salicornia, Scirpus spp., Typha domingensis
- Arthrocnemum, Atriplex, Distichlis, Frankenia, Jaumea, Salicornia

High Marsh

- Arthrocnemum subterminale
- Arthrocnemum, Atriplex, Cordylanthus, Distichlis, Jaumea, Lasthenia, Limonium, Monanthochloe, Parapholis, Salicornia, Spergularia.
- Anemopsis, Typha, Scirpus, Euthamia
- Arthrocnemum, Avena, Bromus, Frankenia, Lolium, Salicornia
- Transitional Wetland/ Ruderal species, (Isocoma, Carpobrotus, Bromus)
- Isocoma, Euthamia (scrub/shrub and upper marsh)
- Mixed Associations (slopes of berms and linear associations, including low and middle marsh types)

Palustrine Wetland

Non-vegetated

- flats and berm crests

Vegetated

Aquatic Bed

- R Ruppia maritima

Emergent Wetland (seasonally flooded) or Saturated (saline affinity)

- Euthamia, Scirpus spp., Typha spp.
- Arthrocnemum, Atriplex, Frankenia, Salicornia
- Arthrocnemum
- Mixed Emergent Wetland and Transitional Upland Species: Bromus, Euthamia, Lolium, Polypogon, Salicornia

Forested Wetland

- Salix

Fig. 13. **CARPI**

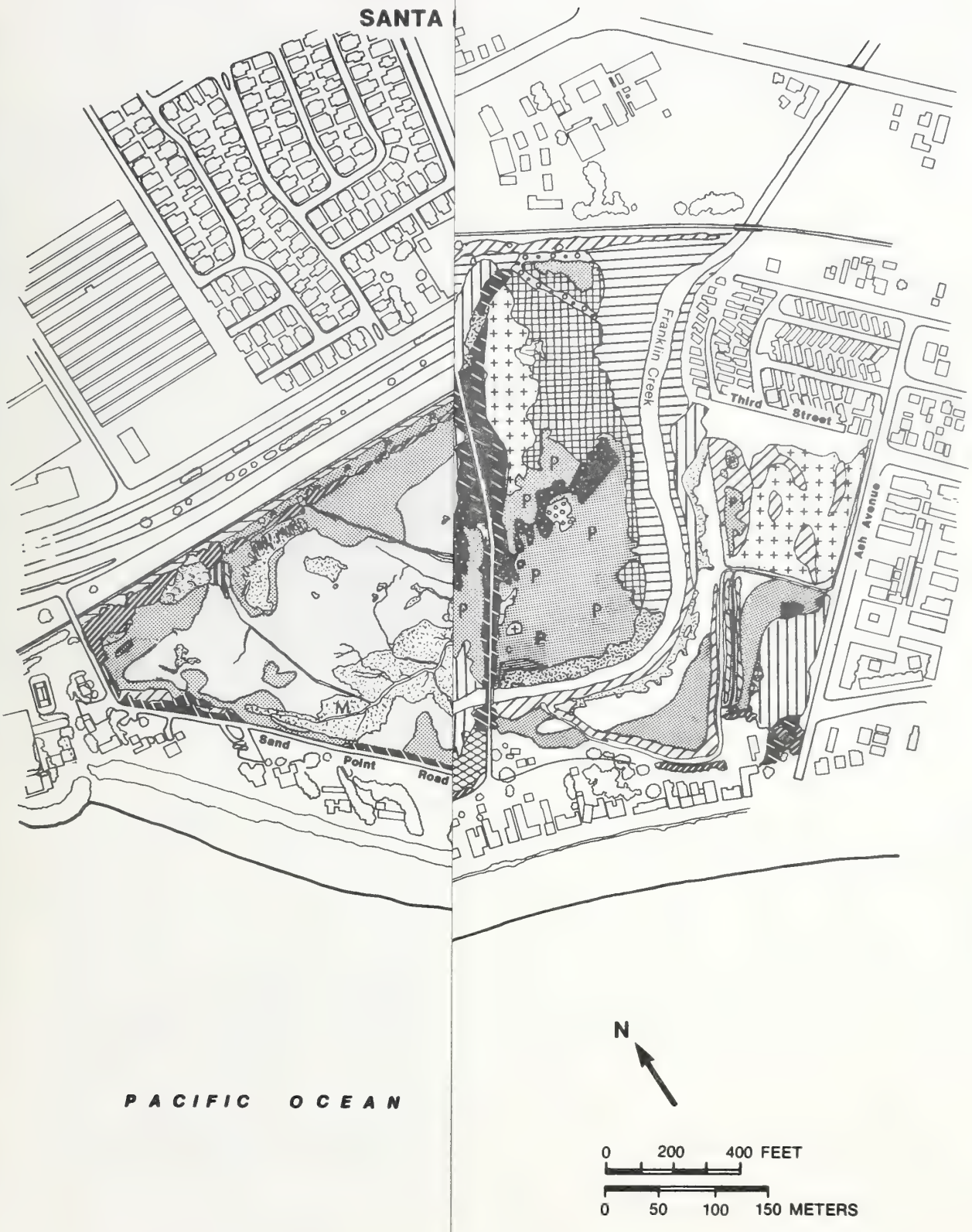
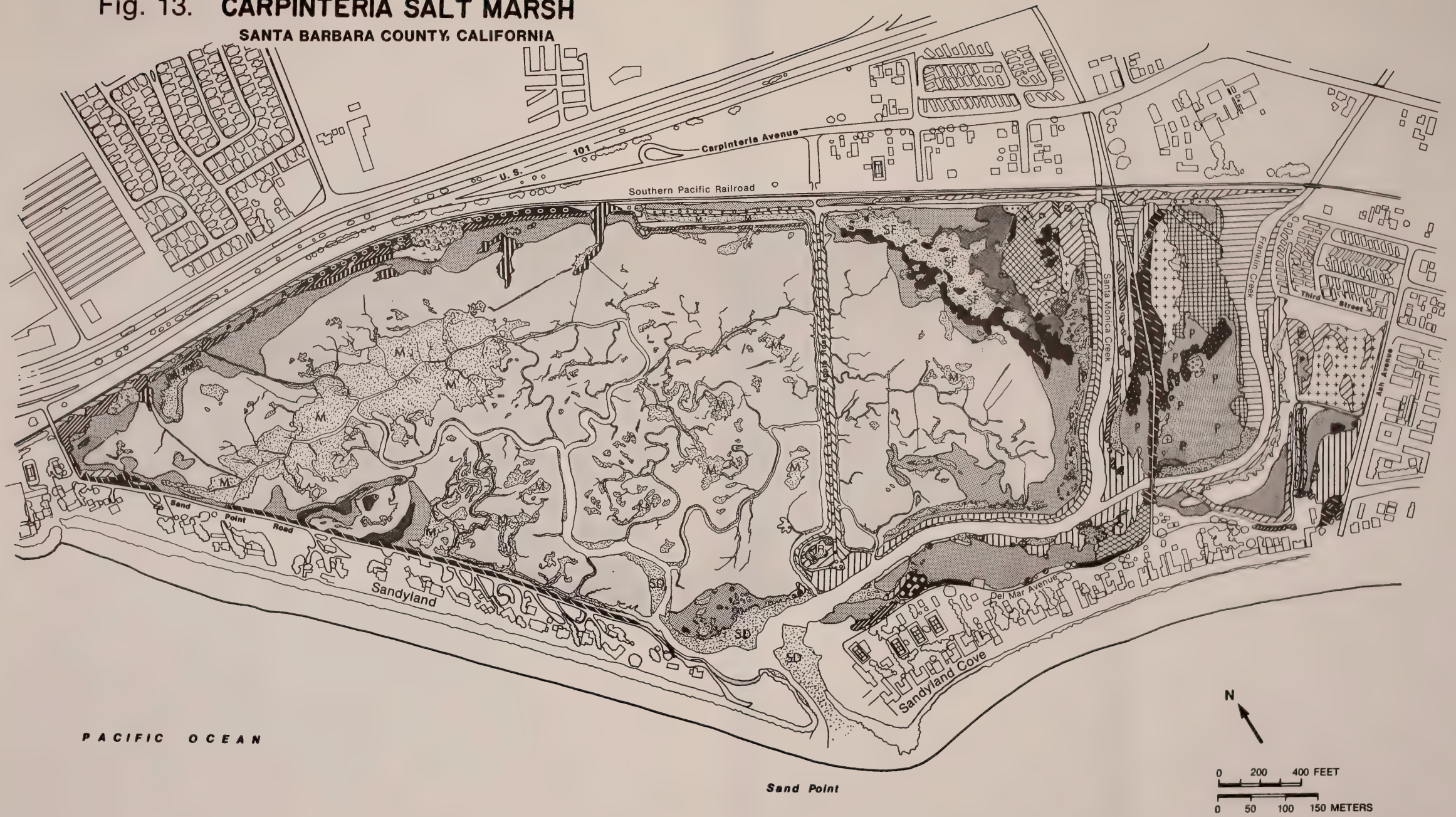

SANTA
Franklin Creek
Third Street
Ash Avenue
Sand Point Road
P
M
PACIFIC OCEAN
N
0 200 400 FEET
0 50 100 150 METERS

Fig. 13. **CARPINTERIA SALT MARSH**

SANTA BARBARA COUNTY, CALIFORNIA



following disturbance. Several habitats supporting this Disturbed Coastal Habitat Vegetation include berms, dredge spoil, roadsides, railroad banks and debris piles.

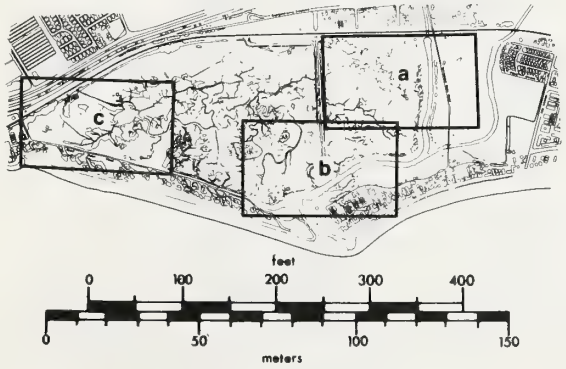
Berms and dredge spoil piles (Figs. 13, 14) contain no vegetation when they are first deposited (Fig. 11), but demonstrate a successional sequence of associations of species (Figs. 15, 16) in years following their origin. For example, first year growth in May, 1980, on dredge spoil at the end of Apple Road was dominated by scattered, prostrate or decumbent low plants, including Atriplex patula, Mesembryanthemum nodiflorum and Spergularia marina. Other plants, either erect in habit or otherwise, included Bassia hypssopifolia, Conyza canadensis, Cotula coronopifolia, Lavatera cretica, Meliotus indica, Rumex crispus, and Salicornia virginica. A number of these are halophytic and hydrophytic species that colonize the saline, poorly drained soil. Third year growth in April, 1982, at this site was dominated by dense often erect plants of Melilotus indicus and Mesembryanthemum nodiflorum, but also included Atriplex patula, A. semibaccata, Bassia hyssopifolia, Bromus diandrus, Cotula coronopifolia, Isocoma veneta, Malva parviflora, Parapholis incurva, Polypogon monspeliensis and Spergularia marina. Some of the hydrophytes such as C. coronopifolia and S. marina were growing in low areas that retained water longer than surrounding habitats and are seasonal wetlands.

At another site along Santa Monica Creek, dredge spoil from the streambed was leveled into a flat-topped berm in 1980. In April, 1981, this site also was characterized by scattered annual species. These included, for example, Atriplex patula, Bassia hyssopifolia, Brassica geniculata, Chenopodium spp., Cotula coronopifolia, Hordeum murinum, Lotus salsuginosus, Medicago polymorpha, Melilotus indicus, Malva parviflora, Salsola iberica, Sisymbrium orientale and Spergularia marina. Listed here are many naturalized ruderal species and several native coastal wetland species. This association is typical of the early successional herbaceous vegetation of berms and dredge spoil.

Fig. 14. VEGETATION MAPS OF SELECTED AREAS OF CARPINTERIA SALT MARSH

LEGEND

Vegetation or habitat classifications terminology is based in part on Cheatham & Haller (1975) for upland, Cowardin et al. (1979) for wetland. Dominate or characteristic genera or species are listed for most vegetated areas but not all species listed are found at all sites. Refer to Appendix 1 and 2 for a more thorough classification of the vegetation and for a complete species list.



UPLAND

Non-Vegetated

berm crests and dredge spoil with occasional salt flats and vernal depressions

Vegetated

Cultivated

Myoporum / mixed exotics

Carpobrotus

gardens

Disturbed Coastal Habitat

Herbaceous Vegetation

roadsides, berm crests and margins, dredge spoil

Disturbed Coastal Habitat/ Palustrine Wetland transition

E — Euthamia

Herbaceous and other plants

debris pile (Arundo, Yucca, Opuntia)

Grassland

+ + + — Cismontane Introduced Grasses (alluvail fan deposits)

Coastal Scrub

A — Artemisia (A), Baccharis (B), Isocoma (I) on alluvial fan deposits; scattered individuals of Salix (S), Malacothamnus (L) and Myoporum (M).

WETLAND

Estuarine Wetland

Non-Vegetated (various water regimes)

channels

mud flats and exposed channels

salt flats

S — sand flats

dredge spoil flats (partly removed)

scraped flats

Vegetated

Emergent Wetland

Irregularly Exposed Wetland

Scirpus maritimus

Regularly Flooded Wetland

Low Marsh

Salicornia virginica

Irregularly Flooded Wetland

Middle Marsh

1 — Distichlis, Frankenia, Salicornia

2 — Arthrocnemum, Frankenia, Salicornia

3 — Arthrocnemum, Distichlis, Frankenia, Salicornia

4 — Salicornia virginica

a — Atriplex

High Marsh

Arthrocnemum subterminale

Arthrocnemum, Lasthenia, Monanthochloe, Parapholis, Spergularia

Arthrocnemum, Atriplex, Cordylanthus, Distichlis, Jaumea, Limonium, Salicornia, Spergularia (sand bar deposits)

Anemopsis, Typha, Scirpus, Euthamia

Lolium, Salicornia

Arthrocnemum, Avena, Bromus, Frankenia Lolium, Salicornia

Transitional Wetland/ Ruderal species, (Isocoma, Carpobrotus, Bromus)

Isocoma, Euthamia (scrub/scrub and upper marsh)

Mixed Associations (slopes of berms and linear associations)

Palustrine Wetland

Non-vegetated

P — flats and berm crests

Vegetated

Aquatic Bed

Ruppia maritima

Emergent Wetland (seasonally flooded) or Saturated (saline affinity)

F — Frankenia, Salicornia

Atriplex, Frankenia, Salicornia

Ar — Arthrocnemum, Salicornia

Arthrocnemum

Bromus, Lolium, Polypogon

Bromus, Lolium, Polypogon, Salicornia

e — Euthamia

t — Mixed Emergent Wetland and Transitional Upland species

Forested Wetland

Salix

Fig. 14a. VEGETATION OF THE ALLUVIAL FAN OF SANTA MONICA CREEK



Fig. 14b. VEGETATION NEAR MOUTH OF THE ESTUARY

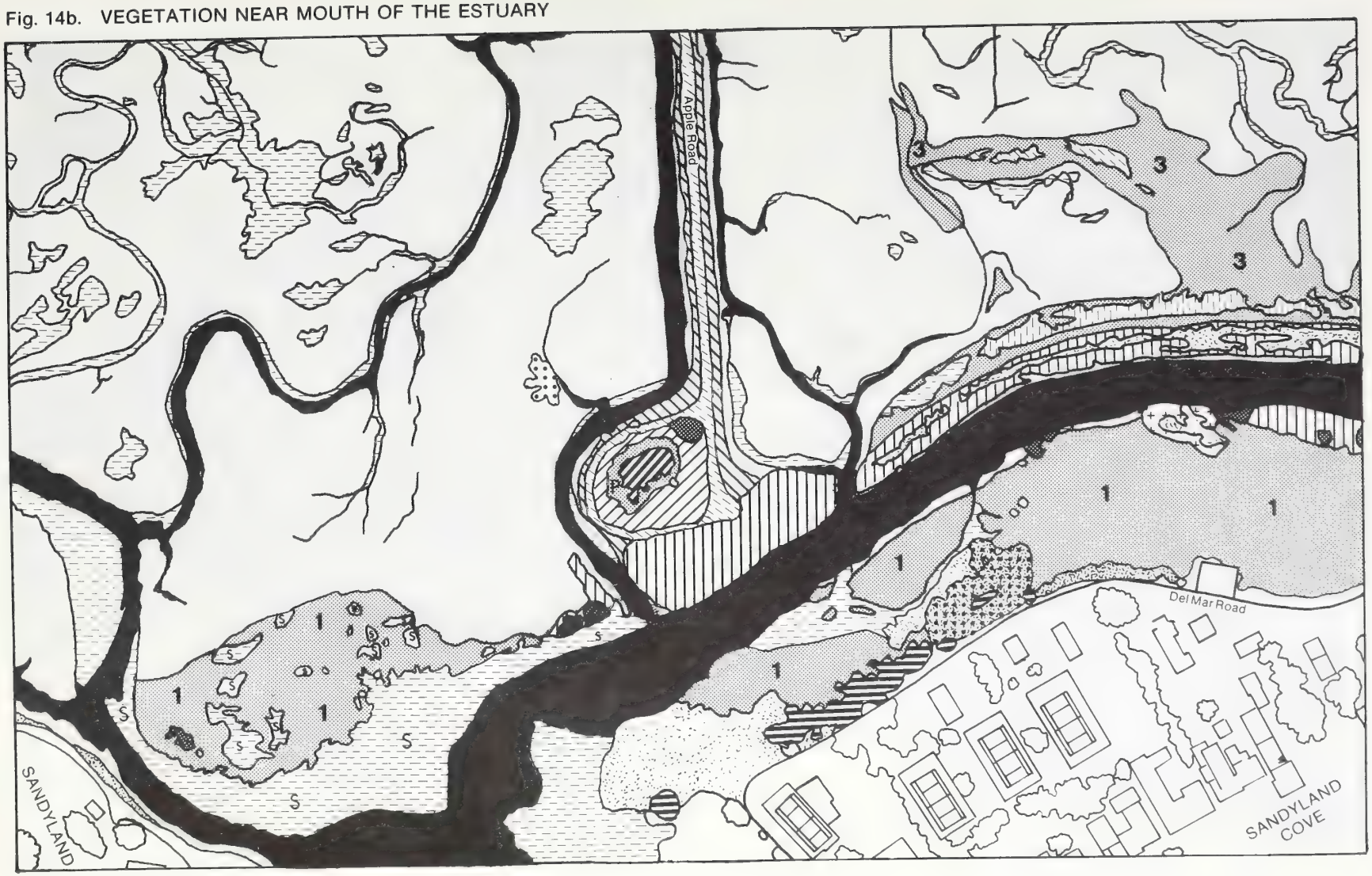
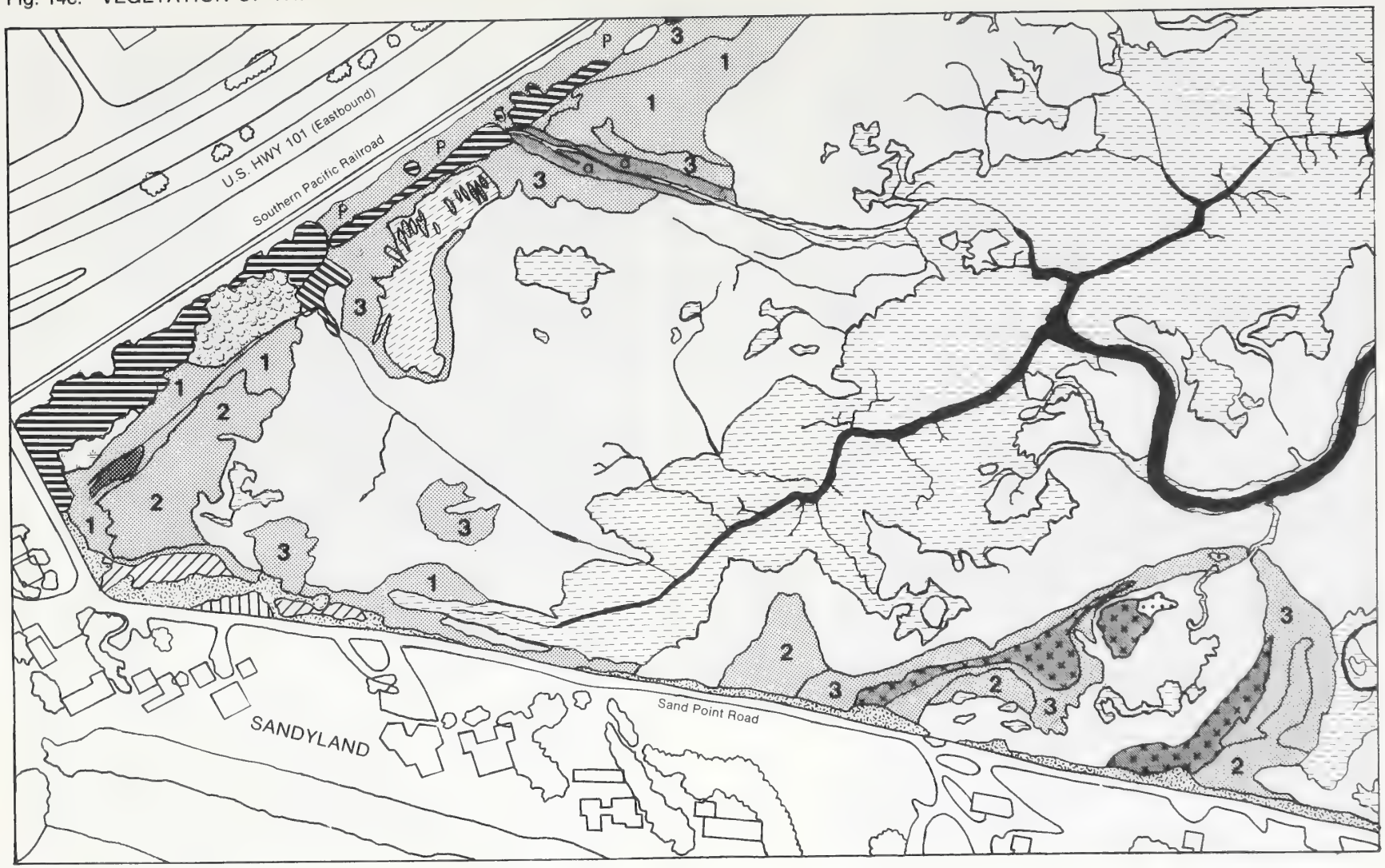


Fig. 14c. VEGETATION OF THE WESTERN END OF THE ESTUARY



Berms that have not been disturbed for several years and have well-drained, even or sloping topography support another association. Late successional herbaceous vegetation on berms (Fig. 16) is usually quite dense and includes naturalized grasses such as Avena fatua, Bromus spp., Lolium multiflorum and Oryzopsis miliacea, numerous naturalized forbs such as Brassica spp., Carduus pycnocephalus, Conium maculatum, Foeniculum vulgare, Melilotus spp., and Raphanus sativus, and many native species. The latter include both those from grassland or riparian corridor habitats such as Ambrosia psilostachya, Artemisia douglasiana, Gnaphalium spp., Hemizonia fasciculata, and Scrophularia californica, and those from high marsh habitats such as Aster subulatus and Euthamia occidentalis. Also of note are naturalized, trailing, succulent shrubs, including Carpobrotus edulis and Malephora crocea. These two species have the potential to eventually dominate large areas of upland.

The vegetation of berm and dredge spoil deposits also is apparently related to the height of the features and degree of slope. Low berms usually support high marsh vegetation while higher berms usually support upland vegetation. Steep slopes often lack zonation of species from wetland to upland types, while gentle slopes usually provide habitat for a variety of associations reflecting water regimes. Furthermore, the age of the berm in association with height, slope and relative disturbance are important factors in determining or predicting the vegetation of this habitat. For example, high berms lacking recent disturbance often support Coastal Scrub, an association discussed in more detail below. Additional information on disturbance and vegetation succession is located in the section on Disturbance and Vegetation Dynamics.

Other examples of Disturbed Coastal Habitat Vegetation include those associations growing on roadsides, railroad banks, and debris piles (Appendix I). Along Sand Point Road, disturbed dune vegetation includes native species such as Ambrosia chamissonis, Camissonia cheiranthifolia, Heliotropium curassavicum and Distichlis spicata, and many naturalized species. Roadsides along paved roads on berms, for example on Sandyland Cove Road, support associations similar to berm



Fig. 15. EARLY SUCCESSIONAL HERBACEOUS VEGETATION: View from end of Apple Road, eastward toward Rincon Mountain. First year successional growth on dredge spoil is by halophytes and plants of poorly drained soils such as *Atriplex patula, Bassia hyssopifolia, Cotula coronopifolia, Melilotus indicus,* and *Spergularia marina.*



Fig. 16. LATE SUCCESSIONAL HERBACEOUS VEGETATION: View northwestward along confluence of Franklin and Santa Monica Creeks. Berm on southern margin of tidal channel is dominated by plants of well drained and leached soils, such as *Bromus diandrus, B. hordeaceus, Carduus pycnocephalus* and many other often weedy species.

vegetation discussed previously. Railroad banks are largely unvegetated, but occasional individuals of naturalized species, including the grasses Chloris gayana, Cynodon dactylon, Pennisetum spp. and Sorghum bicolor, do occur. Debris piles include commercial or residential dump sites that support a wide variety of native, naturalized and persistent cultivated species. One such area on the alluvial fan of Santa Monica Creek provides habitat for many "escaped exotics", including Amaryllis belladonna, Arundo donax, Opuntia basilaris, Pelargonium sp., Tropaeolum majus, Vinca major and Yucca sp. While disturbed coastal habitats account for the majority of naturalized and escaped species, wetlands on the whole support few non-native taxa.

Dune Habitat Vegetation - Coastal sand dunes once occurred along the spits called Sandyland and Sandyland Cove prior to extensive erosion of the coast and the construction of residential development that characterize these areas today (Fig. 8). Likewise, dunes occurred eastward to Carpinteria Creek (Fig. 9a). These habitats supported a variety of dune plant associations, nearly all of which are now absent from the Carpinteria Valley. Today, small pockets of vegetation occur occasionally among houses or on sandy disturbed roadsides (Fig. 17). At the mouth of the estuary on aeolian deposits and sandy dredge spoil is a small area characterized by vegetation called Southern Coastal Foredune and consisting of Abronia umbellata, Ambrosia chamissonis, Cakile maritima, Camissonia cheiranthifolia and others. The remaining habitat not destroyed by the erosion of the coast following construction of the Santa Barbara Harbor or by the construction of homes has been largely covered by the introduced groundcover species Carpobrotus aequilaterus and C. edulis. The transition zone between dune and salt marsh is another narrowly restricted habitat that has been almost entirely eliminated from Carpinteria Salt Marsh. Aspects of the vegetation that characterized this habitat are discussed in the sections on wetlands and flora.

Grassland - Although grassland occurred historically on alluvial deposits surrounding much of the estuary (Fig. 8), little remains of this community today (Figs. 13, 14). Cismontane Introduced Grasses

occur chiefly on the alluvial fan of Santa Monica Creek. This community is characterized by naturalized grasses such as Avena fatua, Bromus hordeaceus and Lolium multiflorum, and native and naturalized forbs such as Conium maculatum, Euthamia occidentalis and Heliotropium curassavicum. At the lower elevations it is usually transitional to high marsh vegetation of both grassland and salt marsh types, and at higher elevations it is associated with species that characterize Coastal Scrub and Disturbed Coastal Habitat Vegetation. Variations of the latter vegetation that contain predominantly grasses on older berms may not be distinguishable from Cismontane Introduced Grasses on natural alluvial fan deposits.

Coastal Scrub - Upland vegetation characterized chiefly by native shrubs occurs on two principal habitats, berms and alluvial fans. Any Coastal Dune Scrub vegetation that might have existed on the sandspits is no longer present. Coastal Berm Scrub (Fig. 18) occurs on older berms that have not received repeated episodes of disturbance. This association can be quite dense or can occur as scattered individuals, and may be composed of species that are typical of Coastal Sage Scrub (e.g., Artemisia californica, Baccharis pilularis, Phacelia ramosissima and Solanum douglasii), or those that characterize more saline soils of Coastal Bluff Scrub (e.g., Atriplex lentiformis and Suaeda californica), or a combination of both. Alluvial fans apparently supported a similar vegetation under natural conditions. Other native species found in both habitats include, for example, Baccharis glutinosa, Ceanothus megacarpus, Malacothamnus fasciculatis and Sambucus mexicanus; and several naturalized species that are occasional include Myoporum laetum, Nicotiana glauca and Ricinus communis.

Cultivated Vegetation - On the margins of the estuary and into the surrounding residential areas there are numerous sites supporting cultivated species planted by homeowners. Some of these occur on vegetation maps of the area (Figs. 13, 14). One prominent feature of Carpinteria Salt Marsh is a row of Myoporum laetum planted on a low berm on the northern margin of the estuary. Additional areas of Myoporum and other exotic trees (e.g., Eucalyptus globulus) are scattered along the



Fig. 17. DISTURBED DUNE VEGETATION: View from Sand Point Road at west end of estuary northwestward toward row of *Myoporum laetum.* Roadside dominants include *Camissonia cheiranthefolia, Bromus diandrus* and *Carpobrotus edulis.*



Fig. 18. COASTAL BERM SCRUB: View westward toward Sandyland Cove Road along berm on north side of Franklin Creek. Dominant shrubs include *Atriplex lentiformis, Artemisia californica* and *Carpobrotus edulis.*

margin of the study area. Extensive beds of Carpobrotus apparently have been planted along Sandyland Cove and Sand Point Roads, although such sites could have resulted from naturalized clones of this genus as well as from cultivation. Small crop gardens also extend into the estuary, particularly at Sandyland Cove, and most residential sites on dunes are characterized by gardens of cultivated exotic species.

Wetland Vegetation

Although the wetland vegetation at Carpinteria Salt Marsh can be grouped (Appendix II) into two major types, intertidal or estuarine, and nontidal or palustrine, there are a number of plant associations (Figs. 13, 14) that generally reflect aspects of water regime, salinity, substrate and disturbance. These wetlands are described below. Elevations used in part to characterize the wetland units are from a Soil Conservation elevation map compiled from a photograph dated 14 June 1974. An analysis of many years worth of tidal flooding data has revealed that inundation exceeds the elevation of 2.48 feet (7.56 dm) above mean sea level (MSL) during 33% of the tides (Copeland, personal communication, 1985). The following tide levels also have been calculated (CDPW, 1960) for the Santa Barbara area: mean low water (MLW) = -1.5 feet (-4.6 dm) MSL; mean high water (MHW) = +2.1 feet (6.4 dm) MSL; mean higher high water (MHHW) = +2.78 feet (8.5 dm) MSL. Onuf (personal communication, 1985) has calculated MHHW at +2.83 feet (8.6 dm) MSL. This information is helpful when elevation of the habitats and height and frequency of tidal inundation are compared with the type and distribution of plant associations.

Irregularly Exposed Estuarine Emergent Wetland - Irregularly exposed ditches and low areas along the northern boundary of the estuary (Fig. 13), where there is an influence of both tidal flooding and freshwater runoff, generally support stands of Scirpus maritimus (Fig. 19) or occasionally support stands of Typha domingensis. Many of the habitats colonized by these species have been affected in some fashion by man-

made alterations of the estuary. However, observations by the author at Carpinteria Salt Marsh and other estuaries suggest that these species occurred along the lower banks of creeks as they emptied into the estuaries and in other topographically low spots that received freshwater runoff or filled with rain water. Salinities were recorded (Nighswonger, 1984) between 3.2 and 9.6°/oo in one permanently flooded ditch that receives runoff and supports patches of this vegetation toward the Northwestern end of the estuary.

Regularly Flooded Estuarine Emergent Wetland - This vegetated wetland type occurs at Carpinteria Salt Marsh (Figs. 13, 14) on flats or channel margins ranging in elevation from about 2.2 to 2.9 feet (6.7 to 8.8 dm) above mean sea level; is usually flooded daily by tidewater; and is characterized by monospecific stands of Salicornia virginica (Fig. 20) or by S. virginica parasitized by Cuscuta salina. It usually is bounded at lower elevations by mud flats that range in elevation from about 1.0 to 2.0 feet (3.0 to 6.1 dm) above MSL--habitats below MHW; and at higher elevations, generally above 2.9 feet, by middle or high marsh vegetation--wetland associations above MHHW.

Zedler (1982) has reported that monospecific stands of S. virginica are often found in marshes with reduced tidal circulation. Revetment installed at the mouth of the estuary permits regular tidal flushing; however, generally high elevations of the low marsh apparently contribute to the lack of environmental conditions for the establishment and maintenance of Spartina foliosa (Cordgrass), another plant that characterizes low marsh vegetation of southern California estuaries. This species occurs in well-flushed estuaries having intertidal habitats that extend into lower elevations such as those of the Tijuana Estuary, where S. foliosa was recorded (Zedler, 1982) at a frequency of greater than 70% between about 0.7 and 1.3 feet (4 dm) above MSL. In the same estuary, S. virginica was recorded at a frequency of greater than 70% between about 1.0 foot (3 dm) and 3.0 feet (9.1 dm) above MSL. Based on these figures, the majority of low marsh habitat at Carpinteria Salt Marsh is in the range of elevation suitable for domination by S. virginica. The higher elevations, 2.3 to 3.0 feet (7-9.1 dm) above



Fig. 19. IRREGULARLY EXPOSED ESTUARINE EMERGENT WETLAND: View from vicinity of Southern Pacific Railroad, southward toward Sandyland. Low areas and ditches are dominated by *Scirpus maritimus* (foreground) and *Typha domingensis* (center).



Fig. 20. REGULARLY FLOODED ESTUARINE EMERGENT WETLAND: View from Apple Road, eastward across low marsh vegetation. Mud flats are dominated by *Salicornia virginica*.

MSL have been considered by some (Zedler, 1982) to be within the range of middle marsh vegetation.

Salinities for numerous stations in the low marsh at Carpinteria Salt Marsh were recorded on two occasions by Nighswonger (1984). He found salinities at low tide in March 1984 to range from 29°/oo along a well flushed channel in the western basin (Basin 3) to 35°/oo along a small channel east of Apple Road near salt flats in the central basin (Basin 2). In June 1984, he recorded salinities at low tide from the same localities and found salinity extremes to occur at the two localities cited above. These salinities were 48 and 71°/oo, respectively. Because no significant rainfall occurred after December 1983, the 1983-84 precipitation year was somewhat unusual and perhaps contributed to the high salinities due to reduced freshwater runoff. This information does emphasize, however, the marine nature of Southern California estuaries. Of additional note are salinities recorded by Nighswonger near the confluence of Franklin and Santa Monica Creeks. In March 1984, he found salinities of 17°/oo on Franklin Creek and 14°/oo on Santa Monica Creek, while in June he recorded them at 47 and 48°/oo, respectively. Thus increasing salinities in the creeks during the drier portion of the year appear to occur as well as in the emergent wetland.

Macdonald (1971) reported on preliminary analysis of salinity data from Goleta Slough and found that the salinity intensity varies with tidal height. For example, he found that salinities for neap-tides ranged from 2 to 34°/oo and for spring-tides ranged 20 to 34°/oo. Macdonald also noted that when the estuary was closed by a sandbar, a salinity gradient of 2 to 20% was established. This gradient apparently reflects sufficient freshwater runoff that maintains lower salinities and offsets the effects of evaporation that could increase salinity in the closed estuary. Macdonald recorded the salinty data between November 1969 and August 1970, a precipitation year that included periods of heavy rainfall and greater total precipitation than the past year when data were obtained for Carpinteria Salt Marsh. It is possible, therefore, that Goleta Slough may also experience periods of

higher salinity during drier years, and that Carpinteria Salt Marsh may have lower salinities during wetter years, or years when the rainfall occurs later in the season.

Irregularly Flooded Estuarine Emergent Wetland - Along a topographic gradient, regularly flooded wetland or low marsh is followed typically by vegetation that is dominated at higher elevations by species characteristic of less frequent flooding (Vogl, 1966; Zedler, 1977). Examination of such a gradient in the Tijuana Estuary (Zedler, 1977) revealed that vegetation change is gradual and there is little evidence for the concept of zones of associations. Nevertheless, with decreasing depth or frequency of flooding there is an increase in the diversity of vascular plants, and most species illustrate varying degrees of tolerance to flooding. In spite of the apparent lack of actual zonation in estuarine wetlands, there have been many examples of classification, nomenclature, and description of the "zonation" or plant associations observed with respect to tidal inundation in southern California (e.g., Vogl, 1966; Warme, 1966; Henrickson, 1976; Macdonald, 1977). Middle and high marsh or their equivalents are names generally applied to wetlands at higher elevations than low marsh.

Although there is disagreement about the boundaries of middle and high marsh and about the species that might characterize them (e.g., Henrickson, 1976; Macdonald, 1977; Zedler, 1982), and although the environmental parameters of wetland types undoubtedly differ among estuaries along a latitudinal gradient (Macdonald, 1977; Zedler, 1982), middle and high marshes are convenient units in which to categorize aspects of the vegetation. For the purpose of this study, both middle and high marsh types are considered Irregularly Flooded Estuarine Emergent Wetland, as defined by Cowardin et al. (1979). Vegetation units within this general wetland category at Carpinteria Salt Marsh were distinguished largely on dominance of characteristic species, proximity to low marsh, and elevation of the habitats. Because of the irregular surface of many middle and high marsh types due to extensive and repeated alterations of the estuary, elevations do not describe middle marsh satisfactorily when associated with characteristic species.

Thus, although mapped associations of the irregularly flooded wetlands have been illustrated (Figs. 13, 14), designation of them within the middle or high marsh associations contains subjective interpretation. However, all middle and high marsh vegetation occurs on habitats that exceed the elevation of MHHW (2.78 feet).

Middle marsh includes two major types (Fig. 13; Appendix II): one with brackish marsh affinities that occurs along the northern boundary of the estuary and has direct influence from freshwater runoff; and another that generally occurs along the higher elevation margins of low marsh vegetation and has more salt marsh affinities. The brackish marsh type occurs at elevations between about 3.0 and 3.3 feet (9.1 and 10.1 dm) above MSL and is characterized by Apium graveolens, Scirpus californicus, S. maritimus and Typha domingensis. The salt marsh type (Fig. 21) occurs at elevations between about 2.9 and 3.7 feet (8.8 and 11.3 dm) above MSL, and is characterized by Distichlis spicata, Frankenia grandifolia, Jaumea carnosa, Limonium californicum and Salicornia virginica. All of these species also occur as understory in the brackish marsh type. Arthrocnemum subterminale, a species that characterizes high marsh vegetation, also occurs here but generally as a few scattered individuals and not as a major component of the vegetation. The higher elevations of middle marsh, particularly about 3.2 to 3.7 feet (9.8 to 11.3 dm), are generally within the range of many high marsh associations, and thus some of the areas mapped as middle marsh may be placed more appropriately in high marsh. This is true of the habitats along the west side of the berm for Santa Monica Creek and the north side of the berms for the confluence of Franklin and Santa Monica Creeks, where scraped flats from old dredge spoil piles support some areas that are dominated by S. virginica and are adjacent to low marsh.

High marsh vegetation includes numerous associations of species (Figs. 13, 14; Appendix II) that reflect various substrates, slopes, flooding and salinity regimes, and disturbances of the habitats. As discussed herein, many plant associations from habitats often considered transitional to uplands are treated as estuarine wetlands because of their dominant species, proximity to more frequently flooded habitats,

and elevations. An important example of high marsh occurs along an elevation gradient associated with natural alluvial fan deposits of Santa Monica Creek (Fig. 14a). A transect over this fan from low to high marsh passes from regularly flooded flats dominated by Salicornia virginica, through middle marsh characterized by S. virginica, Frankenia grandifolia and Arthrocnemum subterminale, to lower high marsh characterized by a narrow monospecific band of A. subterminale at elevations in the vicinity of 3.2 feet (9.8 dm) above MSL. This unique band of vegetation is followed by an unvegetated salt flat.

The upper margin of the salt flat is vegetated by a very interesting and perhaps quite rare association of species (Fig. 22). This estuarine wetland type occurs at elevations from about 3.5 to 3.8 feet (10.7 to 11.6 dm) above MSL, and is dominated by scattered perennials, including small individuals of Arthrocnemum subterminale and open colonies of Monanthochloe littoralis, that persist through the seasonal variation in climatic and estuarine conditions. However, following sufficient winter rainfall and an apparent reduction in soil salinity, many spring annual species colonize the open substrate among the perennials or germinate from beneath and grow above them. The five most common annuals include Juncus bufonius, Lasthenia glabrata (see cover photos), Parapholis incurva, Spergularia marina and Suaeda calceoliformis. Less commonly found are Hordeum depressum and Hymenolobus procumbens.

Upper marsh vegetation such as this alluvial salt flat type is often destroyed by disturbance resulting from urban expansion, flood control activities and other forms of development, and is rather rare today in estuaries of southern California (Zedler, 1982). The type at Carpinteria Salt Marsh may be one of the best preserved examples remaining in the entire region. Although disturbed in part by flood control activities and off road vehicles, this plant association documents a natural occurrence of species that are regionally rare (e.g. Hymenolobus procumbens, Lasthenia glabrata, Hordeum depressum), are usually found at disturbed habitats in the coastal zone rather than their native habitats (e.g. Suaeda calceoliformis), or are common in

both native and disturbed, wet, saline (e.g. Spergularia marina) or freshwater to saline (e.g. Juncus bufonius) habitats. Ecological studies of this vegetation would provide important insight into the high marsh/upland transition.

This salt flat vegetation is transitional to a wet grassland vegetation (Fig. 14a) that also exhibits seasonal variation. During late summer and autumn months the association is characterized by scattered plants of Arthrocnemum subterminale, Frankenia grandifolia and Salicornia virginica. Additionally, scattered colonies of Euthamia occidentalis or shrubs of Isocoma veneta can occur. However, following some winter rain and through early summer much of the vegetation is dominated by a naturalized grassland cover, most frequently characterized by Lolium multiflorum, but also containing Avena fatua, Bromus spp., and a number of introduced forbs (Appendix II). This association occurs at elevations from about 3.9 to 5.0 feet (11.9 to 15.2 dm) above MSL, and apparently contains at the highest elevation upland grassland (Cismontane Introduced Grasses) dominated by Bromus diandrus and B. hordeaceus. Similar alluvial fan grasslands have been described for Goleta Slough (Ferren & Rindlaub, 1983). It is interesting to note that the remnant alluvial fan supporting the various forms of high marsh was apparently formed during the 1914 flood (see HISTORY: Late Historic Period), and is visible on a 1929 aerial photograph. Seed banks for the characteristic native species probably occurred elsewhere in the estuary and were dispersed to the alluvial fan.

Another uncommon and regionally important type of high marsh occurs along the northern margin of Sand Point Road on old sand deposits that represent habitat transitional between dunes and low marsh (Figs. 14b, 23, 24). The greatest diversity of native estuarine species is supported by this high marsh (Appendix II), including the following characteristic species: Arthrocnemum subterminale, Atriplex californica, A. watsonii, Cordylanthus maritimus, Lasthenia glabrata, Monanthochloe littoralis and Spergularia macrotheca. Elevations of the site range from 3.6 to 4.4 feet (11.0 to 13.4 dm) above MSL, although a few sites of the highest elevations from 3.9 to 4.4 feet (11.9 to



Fig. 21. IRREGULARLY FLOODED ESTUARINE EMERGENT WETLAND: View westward along northern edge of estuary. Middle marsh vegetation (foreground) is dominated by *Distichlis spicata, Frankenia grandifolia* and *Salicornia virginica.*



Fig. 22. IRREGULARLY FLOODED ESTUARINE EMERGENT WETLAND: View from salt flat east of Apple Road, eastward toward Rincon Mountain. High marsh vegetation on alluvial fan deposits is dominated by *Arthrocnemum subterminale* (foreground) and wet grassland (center) or upland vegetation (background).

13.4 dm) above MSL support a minor occurrence of Estuarine Scrub/Shrub Wetland characterized by Isocoma veneta. Like other high marsh habitats, this one also has received impacts from development. For example, Sand Point Road was constructed across it, driveways and other forms of residential development have been built on it, and the center of the remaining site described here was used as a borrow pit earlier in the century, leaving two narrow sandbars rather than a broad, flat one (see HISTORY: Late Historic Period). This form of high marsh probably occurred along much of the estuarine side of dune systems at Sandyland, Sandyland Cove and Carpinteria.

High marsh vegetation also dominates some man-made habitats such as berm slopes and low berms or dredge spoil piles. These habitats are quite important at Carpinteria Salt Marsh because they provide areas for native high marsh species to colonize when most native habitats for these plants have been destroyed. Apple Road (Figs. 13, 14c), constructed in the marsh between 1943 and 1947 (see HISTORY: Late Historic Period) is the single most important man-made feature that supports many native estuarine species. Low, middle, and high marsh vegetation occur on its slopes and margins of the crest, and maximum elevations range from 4.9 to 5.7 feet (14.9 to 17.4 dm) above MSL. The higher elevations (5.5 to 5.7 ft) include some grassland and Coastal Scrub elements, suggesting that at least part of the berm might support upland vegetation. Species characteristic of the high marsh vegetation established along the berm include the following: Arthrocnemum subterminale, Atriplex californica, A. watsonii, Cordylanthus maritimas, Distichlis spicata, Monanthochloe littoralis, Spergularia macrotheca, and others (Appendix II).

A final form of estuarine wetland classified as high marsh in this treatment has brackish affinities and is strikingly different from other forms at Carpinteria Salt Marsh. This emergent wetland occurs at the northwestern end of the estuary (Fig. 14c), at perhaps historic freshwater seeps or the historic mouth of Arroyo Parida, on a low, narrow terrace near elevation 3.8 feet (11.6 dm) above MSL, and supports the following characteristic species: Anemopsis californicus, Baccharis



Fig. 23. IRREGULARLY FLOODED ESTUARINE EMERGENT WETLAND: View northward from vicinity of Sand Point Road. High marsh on sandbar is dominated by many species, including *Arthrocnemum subterminale, Atriplex patula, Frankenia grandifolia* and *Limonium californicum.*



Fig. 24. IRREGULARLY FLOODED ESTUARINE EMERGENT WETLAND: High marsh on sandbar is dominated by many species, including *Arthrocnemum subterminale, Atriplex californica, A. patula, Frankenia grandifolia, Salicornia virginica,* and *Spergularia macrotheca.*

douglasii, Equisetum telmateia, Euthamia occidentalis, Scirpus californicus, and Typha domingensis (Fig. 25). Although this vegetation has not been documented from other estuaries on the South Coast (e.g. at Goleta Slough), a variation of it is an important component of the Santa Ynez and Santa Maria River Estuaries on the North Coast of Santa Barbara County.

The high marsh wetlands described herein are units of vegetation that occur only as remnants, disturbed examples, or forms established on man-made structures. Thus, it is difficult to be certain of the extent and diversity of types that might have occurred at Carpinteria Salt Marsh. However, there are documented herein a substantial number of high marsh types that suggest the original extent and diversity for this and other southern California estuaries.

Estuarine Scrub/Shrub Wetland - Estuarine wetland characterized by shrubs is rare at Carpinteria Salt Marsh. It exists generally as a few scattered individuals within other forms of vegetation and perhaps is even more difficult to reconstruct than emergent high marsh types. On slopes or banks of berms generally above mean high tide Atriplex lentiformis and Suaeda californica occur and represent the more saline Scrub/Shrub Wetland native to the region. However, both are important components of Coastal Bluff Scrub. They may have found suitable habitat on berms but may not be a natural component of the estuarine system. Similar vegetation has been reported for Goleta Slough (Ferren & Rindlaub, 1983). Another form of Scrub/Shrub Wetland occurs on alluvial fan deposits, sandbars and other areas of low topographic relief. These sites may have scattered or numerous individuals of Baccharis pilularis or Isocoma veneta, are often transitional to upland or palustrine wetland habitats, and probably represent native forms of vegetation. While wetlands dominated by both species are rare at Carpinteria Salt Marsh, both occur at Goleta Slough, where wetlands characterized by B. pilularis are common, often dense, and usually transitional to Palustrine Scrub/Shrub Wetland.

Palustrine Aquatic Bed - Palustrine wetlands dominated by submerged rooted vascular or floating species are grouped together in the aquatic

bed wetland type. Two examples occur at Carpinteria Salt Marsh. At the south end of Apple Road in a depression that is filled with rainwater, Ruppia maritima occurs in abundance. This seasonally flooded, rooted vascular, Palustrine Aquatic Bed occurs at no other site in the vicinity of the estuary. However, at several sites at Goleta Slough (Ferren & Rindlaub, 1983) and at Devereux Slough extensive beds of R. maritima occur in various diked or impounded palustrine and estuarine habitats, but rarely in more regularly flooded estuarine situations. Thus, among the three estuaries R. maritima occupies similar habitats. Because Carpinteria has fewer impounded saline areas, it apparently supports only a minor occurrence of rooted vascular aquatic bed vegetation.

Seasonally or permanently flooded, floating, Palustrine Aquatic Bed occurs in nontidal, freshwater ditches along the northern margin of Carpinteria Salt Marsh adjacent to the Southern Pacific Railroad. Lemna minor is the only species observed recently; however, Lemna gibba was collected previously from stagnant pools on Franklin Creek at the railroad. The floating aquatic bed vegetation usually occurs in monospecific colonies in open pools or as scattered groups floating among emergent stems of other forms of palustrine wetland.

Palustrine Emergent Wetland (freshwater affinities) - Persistent, emergent species with freshwater or brackish water affinities occur in ditches, depressions, and seeps along the northern margin of Carpinteria Salt Marsh (Figs. 13, 26). All Palustrine Emergent Wetland has been extirpated from lower Franklin and Santa Monica Creeks because of flood control activities. However, agricultural, highway, and other man-made drainage ways provide runoff that support many emergent species. Salinity measured from greenhouse runoff was recorded at 3.2°/oo in June, 1984, indicating runoff is brackish at least occasionally (Nighswonger, 1984). The plants generally form tall, dense marsh vegetation, including largely native species such as Aster subulatus, Baccharis douglasii, Euthamia occidentalis, Equisetum elmateia, Juncus textilis, Polygonum punctatum, Scirpus microcarpus, Typha domingensis, T. latifolia and Urtica dioica. Other species grow in areas of exposed, often disturbed substrates, and are frequently low growing or erect

annuals that do not persist as long as the other plants. These include native species such as Atriplex patula, Cardamine oligosperma, Epilobium ciliatum, Juncus bufonius and Xanthium strumarium, or include naturalized species such as Anagallis arvensis, Cotula coronopifolia, Nasturtium officinale, Poa annua, Polypogon spp., and Rumex crispus.

A more natural occurrence of palustrine and even riverine vegetation once associated with Carpinteria Salt Marsh still grows along Carpinteria Creek and is contiguous to estuarine wetlands that occur at the mouth of that creek. Vegetation of the streambed above the estuary includes Cotula coronopifolia, Cyperus spp., Juncus spp., Nasturtium officinale, Veronica anagallis-aquatica and others (Appendix III). Vegetation of the seasonally emergent floodplain includes Equisetum spp., Juncus spp., Rumex spp., Scirpus microcapus, and others.

The transition between Estuarine Emergent Wetlands and Palustrine and Riverine Wetlands is an uncommon habitat in southern California and rarely documented in the South Coast (Ferren & Rindlaub, 1983). While once existing on three streams that entered into the historic estuary, the transition has been eliminated from Franklin and Santa Monica Creeks, and is reduced to a small area on Carpinteria Creek. This transition does provide, however, some rare evidence of the natural occurrence of this vegetation. For example, the upstream end of a brackish lagoon at the mouth of Carpinteria Creek contains an emergent sandbar that extends upstream along the margin of the creek and becomes a low elevation floodplain. The downstream seasonally flooded portion of the sandbar supports estuarine species such as Salicornia virginica, Scirpus maritimus, Distichlis spicata, and Atriplex patula. Naturalized species associated with these include Agrostis semiverticillata, Cotula coronopifolia, Lolium multiflorum, Polypogon monspeliensis, and Rumex crispus. Higher elevations on the low floodplain that are less frequently flooded support a shrub/scrub association of Baccharis glutinosa and Salix lasiolepis. Farther upstream the estuarine association along the margin of the bar is replaced by a Palustrine Emergent Association that includes native species, such as Cyperus cragnostis and Juncus xiphioides, and numerous naturalized hydrophytic and weedy species.



Fig. 25. IRREGULARLY FLOODED ESTUARINE EMERGENT WETLAND: View eastward along northwestern margin of estuary. High brackish marsh vegetation (center) is dominated by *Anemopsis californica*, and middle salt marsh vegetation by *Salicornia virginica* and *Frankenia grandifolia*.



Fig. 26 PALUSTRINE EMERGENT WETLAND (freshwater affinity): View southward from vicinity of Southern Pacific Railroad. Marsh vegetation in seasonally flooded ditch is dominated by *Scirpus microcarpus* and *Typha latifolia*.

This transition zone on Carpinteria Creek occurs in a riparian corridor, the upper banks of which are characterized by Palustrine Forested Wetland.

Palustrine Emergent Wetland (Saline affinities) - There are two major occurrences of Palustrine Emergent Wetland on saline substrates (Appendix II). One form is composed of persistent perennials and non-persistent annuals that generally grow on seasonally flooded or saturated habitats such as depressions, disturbed and compacted substrates, and tops of berms. These habitats can be referred to as saline vernal wetlands and are similar to the native vegetated salt flats of alluvial fans. Examples include portions of Apple Road, a berm west of Apple Road (Fig. 27), and berms along Santa Monica Creek. Along access roads on these berms, poorly drained, compacted, saline soils in depressions support various species, including Arthrocnemum subterminale, Bassia hyssopifolia, Cotula coronopifolia, Hordeum geniculatum, Mesembryanthemum nodiflorum, Parapholis incurva, Suaeda calceoliformis, and others. Many more introduced species occur here than on the high marsh alluvial fan habitat. Similar vegetation occurs on disturbed alluvial sediments east of Sandyland Cove Road (Fig. 28).

Another form of Palustrine Emergent Wetland occurs on saline substrates and consists largely of perennial plant cover. For example, diked salt marsh and impounded ditches support vegetation similar to estuarine wetland but without the influence of tidal inundation. The alluvial fan deposits of Santa Monica and Franklin Creeks east of Santa Monica Creek and Sandyland Cove Road (Fig. 13, 14a) support a variety of associations that have flooded or saturated soils resulting from rainfall and runoff. There is a striking similarity between the estuarine wetlands west of Santa Monica Creek and those to the east where berms have reduced or completely eliminated tidal influence. Similar habitats are common at Goleta Slough (Ferren & Rindlaub, 1983) where much more of the estuarine wetland has been diked. Dominants include Arthrocnemum subterminale, Atriplex patula, Distichlis spicata, Frankenia grandifolia, Lolium multiflorum and Salicornia virginica, and depending



Fig. 27. PALUSTRINE EMERGENT WETLAND (saline affinity): View westward along berm south of Southern Pacific Railroad. Partially vegetated saline vernal flat on berm is seasonally saturated and dominated by many species, including *Atriplex patula, Bassia hyssopifolia, Hordeum geniculatum, Mesembryanthemum nodiflorum, Parapholis incurva,* and *Suaeda calceoliformis.*



Fig. 28. PALUSTRINE EMERGENT WETLAND (saline affinity): View from diked portion of marsh northward toward "Old Town." Partially vegetated saline vernal flats, formed on alluvial fan deposits east of Santa Monica Creek, are dominated by *Arthrocnemum subterminale, Bassia hyssopifolia, Cotula coronopifolia,* and *Salicornia virginica.*

on the degree of seasonal flooding may vary from emergent wetland dominated by succulent perennials to grassland (Fig. 29).

Palustrine Scrub/Shrub Wetland - Vegetation contiguous to and transitional with estuarine wetlands probably included Palustrine Emergent and Scrub/Shrub Wetlands. The mouth of Carpinteria Creek once supported abundant willows that suggest this situation. Disturbance along the margins of Carpinteria Salt Marsh and Franklin and Santa Monica Creeks has resulted in the elimination of some forms of wetland and the creation of habitats that support others. Depressions in alluvial fans and ditches along the Southern Pacific Railroad have provided habitat for scattered individuals or small groups of shrubs that indicate what the composition of this wetland might have been. Species present include Baccharis glutinosa, B. pilularis, and Salix lasiolepis. Low elevation sandbars on Carpinteria Creek currently support scattered individuals of B. glutinosa and S. lasiolepis.

Palustrine Forested Wetland - Forested wetland (Fig. 30) occurs in two forms in the region of Carpinteria. Riparian Woodland vegetation was apparently common along Franklin and Santa Monica Creeks, and still occurs today along Carpinteria Creek near its mouth, where Alnus rhombifolia, Populus trichocarpa, Salex laevigata, S. lasiolepis, and S. lasiandra characterize the association. However, in the vicinity of Carpinteria Salt Marsh only a monospecific stand of Salix lasiolepis occurs on the northern margin of the estuary at the site where a previous drainage emptied into the marsh. The trees grew following the creation of the ditch in the 1950s and were evident in aerial photographs by 1961. Associated with S. lasiolepis are various understory shrubs, including Myoporum laetum, Pittosporum undulatum, Ribes menziesii, and Rubus ursinus, and perennial herbs, including Artemisia douglasiana, Juncus patens, Rumex salicifolius, and Stachys bullata.



Fig. 29 TRANSITIONAL PALUSTRINE EMERGENT WETLAND: View from diked area of marsh southward toward Sandyland Cove. Wetland is dominated by *Lolium multiflorum* (foreground) and *Arthrocnemum subterminale* (left center), and is transitional to Cismontane Introduced Grasses (right center).



Fig. 30. PALUSTRINE FORESTED WETLAND: View from estuary northward toward the Santa Ynez Mountains. Forested wetland (background) is dominated by *Salix lasiolepis*; brackish marsh (center) by *Scirpus californicus, S. maritimus,* and *Typha domingensis*; and salt marsh (foreground) by *Salicornia virginica.*

BIOMASS AND PRODUCTIVITY

Vascular plant biomass and productivity were measured at Carpinteria Salt Marsh by Onuf (1984c) as part of pre-project monitoring for the El Estero Marsh Enhancement Project. He found that both biomass and productivity were not significantly different within the various areas measured even though different elevations occurred and different tidal inundation regimes were expected. Onuf reported that this lack of difference may reflect the response of Salicornia virginica, the dominant plant of emergent wetlands. It has a wider elevational range than any other plant of estuarine wetlands in southern California, and hence might not be very sensitive to variation in tidal inundation even over a wide range. Onuf found that the mean primary productivity of Carpinteria Salt Marsh was approximately 500 g dry weight m^{-2} y^{-1}. He noted that this figure is less than half of that he measured for Goleta Slough, also in Santa Barbara County, during the previous year.

One explanation for the difference in measurements of primary productivity at the two estuaries is that most of the precipitation in 1984 occurred before the growing season, while in 1983 it occurred during the growing season (Onuf, 1984c). Zedler (1982) suggested that high soil salinity is probably the major limiting factor for vascular plant growth in southern California. Precipitation leaches salts from the soil and during the growing season this process apparently stimulates productivity. Zedler also observed that total above ground productivities determined for less disturbed, seasonally hypersaline salt marshes of southern California are well below estimates for salt marshes along the Atlantic and Gulf of Mexico coasts of North America.

The relationship between soil salinity and productivity is evident not only in vegetation dominated by Salicornia virginica and other perennial species of salt marshes, but also in high marsh vegetation characterized by scattered perennials and abundant annual species. As noted previously, this annual flora occurs in areas of high salinity, such as alluvial fan deposits above mean higher high water, where salt

concentrations limit the growth of perennials but permits the growth of annuals when salts are leached from the soil by winter rainfall. At Carpinteria Salt Marsh the density and total biomass of annual species is also clearly related to the occurrence and amount of precipitation.

DISTURBANCE AND VEGETATION CHANGE

As described in previous sections of this publication, the vegetation of Carpinteria Salt Marsh is both complex and variable. Much of this complexity and variability is due to natural and man-made disturbance in the estuary or on the surrounding uplands. Five types of disturbance, including catastrophic short-term flooding, long-term flooding due to closure of the mouth of the estuary, localized freshwater runoff, fragmentation of the estuary, and infilling of wetlands, have had significant effects on the composition, distribution and dynamics of the vegetation. An additional type of disturbance, water pollution, has had indirect, implied, or unknown impacts, or may affect the estuarine emergent vegetation in the future. Descriptions of these 6 disturbances and their effects on the estuary are presented below.

Catastrophic Short-Term Flooding - Large winter storms with abnormally high amounts of rainfall are an uncommon event in the Santa Barbara County region. However, when they occur substantial erosion of the watershed is possible, particularly in areas where there have been recent fires or grading. The runoff from such situations may exceed stream channel capacities, resulting in catastrophic flooding of the Carpinteria Valley, including Carpinteria Salt Marsh (Fig. 31). One product of this flooding is the deposition of sediments on the lower slopes of the valley and in the estuary as the carrying capacity of streams is reduced. The initiation and growth of alluvial fans that have filled the basin apparently result from this uncommon occurrence of major erosion, flooding and deposition.

Floods of significant magnitude have been recorded for the Carpinteria Valley in the following years: 1862, 1875, 1877, 1883, 1888, 1907, 1909, 1911, 1914, 1918, 1927, 1937, 1938, 1941, 1943, 1952, 1955, 1956, 1958, 1962, 1965, 1966, and 1967 (Division of Soil Conservation, 1967); and 1969, 1971, 1978, and 1983. Table V summarizes aspects of stream flow and flood data for this period. Of particular note is the magnitude of the flood in 1914 (Table V-A). A storm in January of that year produced about 6 inches of rainfall in the mountains in 20 hours (Clark, 1962). The subsequent flood covered about 1250 acres and was of the magnitude that is predicted to occur only about 1%/o of the time or about once every hundred years. Such a flood has not recurred since 1914. Flood control measures implemented but not completed for the region are designed to minimize the impacts from such storms.

The 1914 flood had significant impact on Carpinteria Salt Marsh and vicinity. According to Clark (1962), "Old Town" was covered with 4 or 5 feet of water and was raised in elevation about 2.5 feet. While these figures may not be accurate, they suggest the volume of sediment that was deposited in the basin. Some of this sediment formed a large alluvial fan that also was deposited in the estuary (Division of Soil Conservation, 1967), upon which various plant associations now occur. Although extensive low marsh was lost as a result of this natural infilling, uncommon high marsh habitats were provided by the lower elevations of the alluvial fan. These uncommon habitats support several regionally rare species.

An additional impact to the natural resources of the area as a result of the storms in 1914 included extensive erosion along the coast where the sand dunes were largely washed away (Clark, 1962). It is probable that high marsh habitats with sandy substrates on the estuarine side of the dune system have been created during these periods of intensive marine erosion of the coast. Waves surging over the dunes apparently have carried sand into the estuary, causing the development of high marsh flats. As discussed previously, these uncommon habitats have the greatest diversity of native estuarine plant species existing at Carpinteria Salt Marsh, and also provide habitats for rare plants.



Fig. 31. CARPINTERIA SALT MARSH (Winter Flood, 1983): a. View from Carpinteria, northwestward toward Summerland; b. View from Sand Point, northeastward toward Carpinteria; c. View from Sandyland Cove, northeastward toward "Old Town." Note the flooding of the Estuarine Emergent Wetlands resulting from a storm in 1983, and the still obvious occurrence of an alluvial fan that was deposited in the estuary south of Old Town by Santa Monica Creek as a result of the severe winter storm in 1914. Photographs from Santa Barbara County Flood Control and Water Conservation District.

Another result of catastrophic short-term flooding is the temporary or permanent alteration of stream courses that flow into Carpinteria Salt Marsh. For example, Arroyo Parida Creek emptied into the western end of the estuary until it changed its course to a more southerly one near Serena (Stockton, 1960), apparently as a result of the 1862 storm and subsequent flood. This has had a tremendous effect on the size of the watershed and the amount of runoff that drained into Carpinteria Salt Marsh. More recently, Arroyo Parida Creek temporarily reclaimed a channel to the estuary during the storm of January 1969. As evident on aerial photographs reviewed by the author, the stream flowed across alluvial deposits to the Southern Pacific Railroad, came through drainage channels, and finally emptied into the northwestern margin of the marsh. Other temporary changes resulting from this storm included the overflow of Santa Monica Creek into Franklin Creek north of US Highway 101, a minor overflow from Carpinteria Creek into Franklin Creek, the overflow from Franklin Creek into the basin west of it, the drainage of Santa Monica Creek westward over its alluvial fan into the basin between it and Apple Road, and the drainage of flood waters north of US Highway 101 through ditches and into the estuary west of Apple Road. All of these temporary changes in drainage produced topographic changes in the estuary that affected the distribution of various wetlands. The deposition of sediment and the cutting of new drainageways are long-term results of the short-term flooding.

Severe flooding in December 1971, deposited about 100,000 tons of silt into Carpinteria Salt Marsh (USDA Soil Conservation Service, 1983). The channel of Santa Monica Creek was blocked with sediment and the alluvial fan was raised in elevation. Subsequent dredging resulted in the deposition of spoil into the marsh along the western bank of Santa Monica Creek, eliminating about 15 acres of low marsh vegetation. Although this spoil was removed after a period of drying, the elevation of the marsh was changed and unvegetated flats still occur in the marsh along the present berm because they were not graded properly.

Storms during the winter of 1983 produced several periods of extensive flooding at Carpinteria Salt Marsh (Fig. 31 a-c) and other areas

TABLE V. STREAM FLOW AND FLOOD DATA FOR CARPINTERIA VALLEY

A. Carpinteria Creek (Division of Soil Conservation, 1967)

Flood	Area Inundated* (Acres)	Peak Flow (CFS)	Flood Frequency
January 1914	1,250	--	1%
January 1952	554	2,440	3.5%
February 1962	100	1,160	13.5%
April 1965	10	325	37%
November 1965	179	1,510	9%

B. Franklin Creek (Woodward-Clyde, 1982)

Water-year	Annual Discharge (AFY)	Average Daily Discharge Rate (CFS)	
		minimum	maximum
1970-71	279	0.01	136
1971-72	426	0.07	1,600**
1972-73	1,080	0.09	689***
1973-74	482	0.10	119
1974-75	398	0.08	200
1975-76	558	0.11	573
1976-77	302	0.07	>210
1977-78	1,500	0.02	1,210

* - Excludes areas along Carpinteria Creek and in Carpinteria Salt Marsh.

** - 10% design storm.

*** - 20% design storm.

along the immediate coast, although there was not widespread flooding throughout the Carpinteria Valley. Flood control channels for Franklin and Santa Monica Creek directed much of the runoff to the mouth of the estuary, preventing the additional growth of alluvial fans (Fig. 31c). However, sediment did accumulate at the mouth where beach sand also was washed into the estuary (Fig. 31b). Additionally, waves breached or topped the dune system in spite of the sea wall (e.g., Fig. 31b), and apparently caused a renewed deposition of sand into the estuary, as seen by a light area in the marsh toward the western end of Sandyland in Figure 31a. Thus, the force of moving water in the form of runoff and marine wave action has caused significant changes to this estuarine system. Much of the distribution and composition of the vegetation of Carpinteria Salt Marsh has been affected by these forces. Furthermore, Zedler (1982) has observed that flood events also apparently play an important role in allowing halophytes to invade additional habitats that otherwise are too saline for germination to occur. This phenomenon has not been investigated at Carpinteria Salt Marsh, although halophytes do invade new habitats created by floods.

Long-term Flooding Caused by Closure of the Mouth - Estuaries of southern California occur in a region of seasonal rainfall, and thus many do not receive sufficient runoff to maintain a flow to the ocean during dry periods. The coastal drift of beach sands frequently closes the mouths of these estuaries for various periods of time, preventing tidal circulation. Zedler et al. (1980) and Zedler (1982) have summarized the effects of reduced tidal circulation on the emergent vegetation of estuarine wetlands of Southern California. These effects include changes in soil salinity to more brackish or more saline conditions, and changes in soil moisture to drought or flooded conditions. She suggests that species sensitive to these fluctuating conditions would be eliminated from wetlands, while widely tolerant species would dominate.

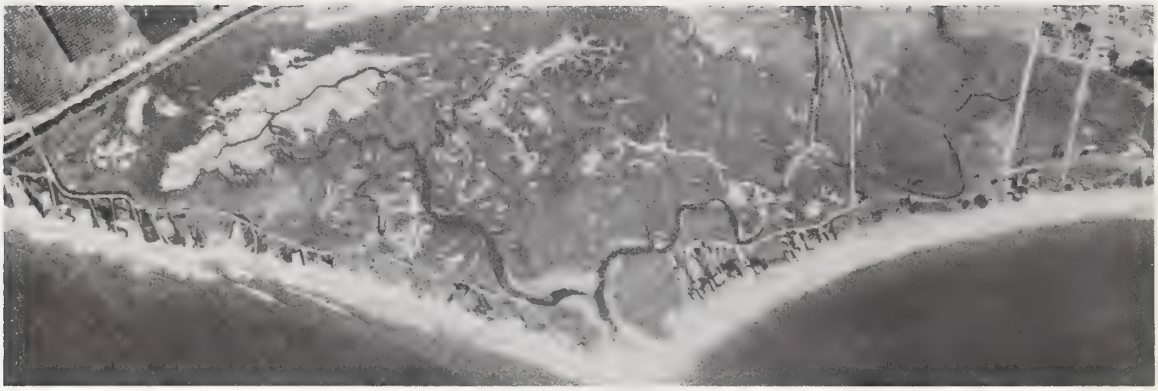
As reported briefly in the section HISTORY: Late Historic Period, examination of about 50 years of aerial photographs, associated with records from the Santa Barbara County Flood Control and Water Conservation District and extensive field work at the estuary, has provided

important information about the response of vegetation to alternations of tidal circulation, flooding and closure of the mouth of the estuary. Specifically, closure of the mouth, apparently for a period of several years, resulted in the ponding and stagnation of runoff water. This long term flooding in turn apparently caused the death of extensive areas of Salicornia virginica that dominated the low marsh of the western basin. Return of tidal circulation eventually resulted in the return of S. virginica.

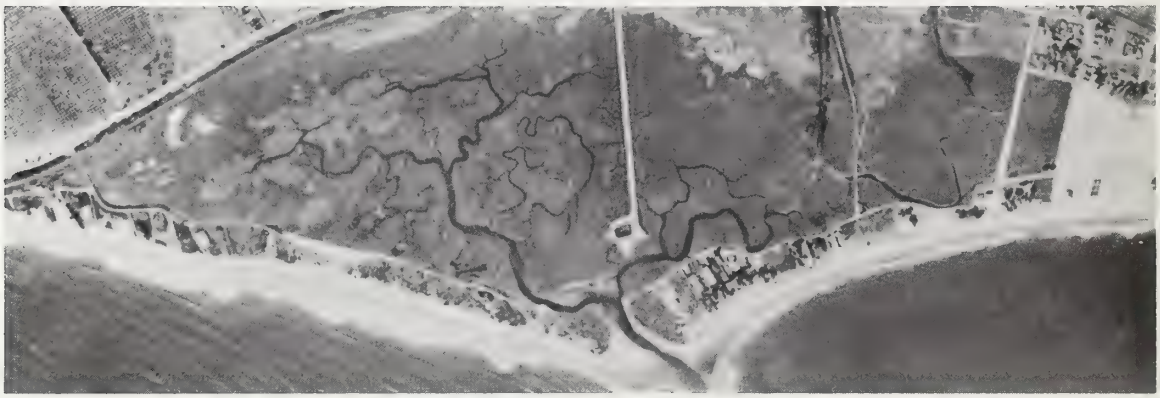
A detailed analysis of this process is possible because of the availability of aerial photographs (Figs. 32a-h). Closure of the mouth historically was probably a regular seasonal phenomenon, as is typical of many southern California estuaries. In 1943 (Fig. 32a), the mouth of the estuary was blocked by sand, and with water occurring only in channels, many of the flats appear in a desiccated state. It is interesting to note that a flood is reported (Division of Soil Conservation, 1967) for this year, but it must have occurred after this photograph was taken. In contrast, the estuary had good tidal circulation for at least part of 1947 (Fig. 32b). The low marsh was dominated by S. virginica except at elevations that receive excessive flooding, such as in channels and on mud flats. However, by 1954 (Fig. 32c) the mouth of the estuary was closed again. This closure must have been for a long time, because not only are the channels and portions of the marsh flooded by standing water, but there appears to be a decline in the density and extent of S. virginica with a corresponding increase in unvegetated flats, channels and ponded areas. Although Apple Road was built between 1943 and 1947 and could have had some impact on circulation in the marsh, it had functioning culverts that permitted circulation between eastern and western portions of the marsh, and probably did not contribute to the decline of S. virginica. Macdonald (1976) reports that the estuary was closed for much of the period between 1953 and 1966.

A large sand plug is evident at the mouth of the estuary by 1961 (Fig. 32d), and although there may have been some seasonal flushing and tidal circulation, the general condition of the ecosystem appears to have changed significantly. Figure 32d illustrates a period of

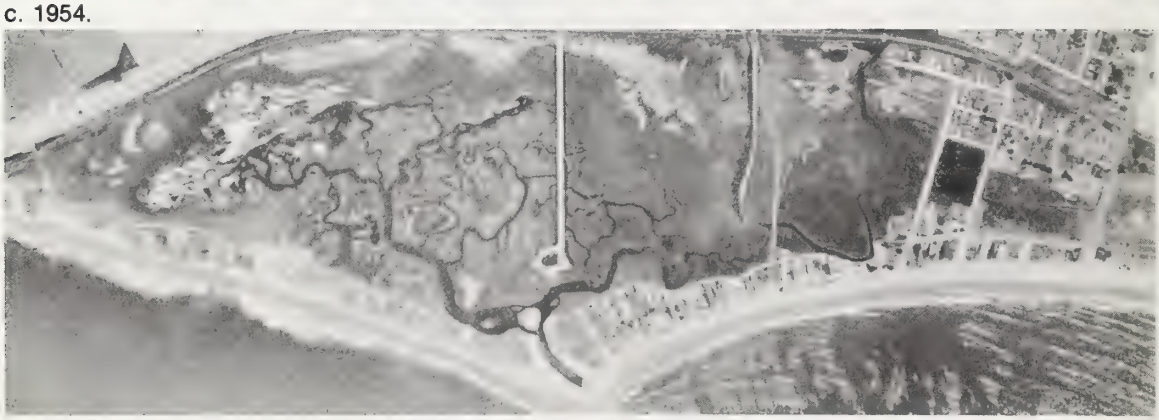
a. 1943.



b. 1947.



c. 1954.



d. 1961.

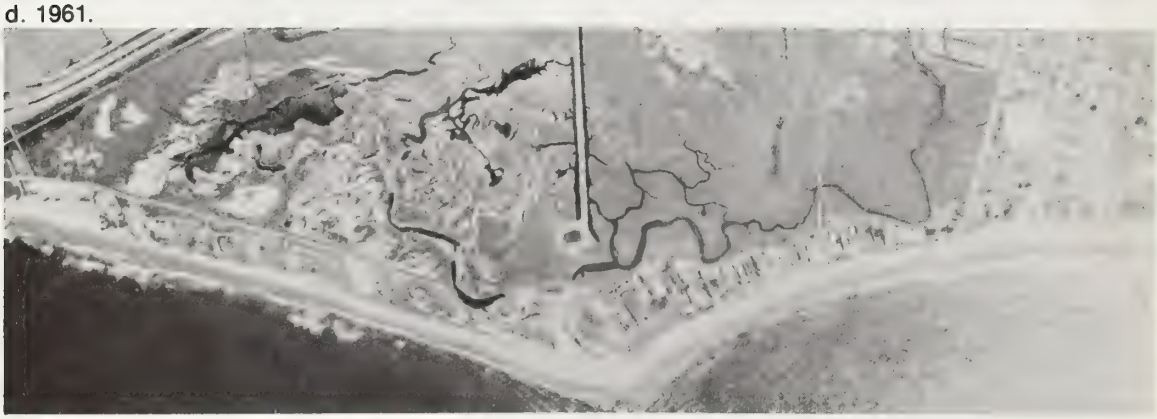
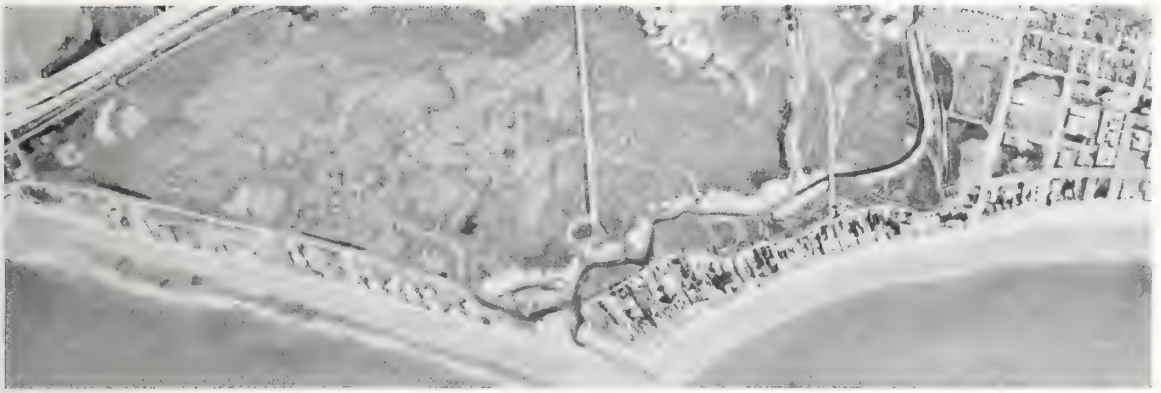
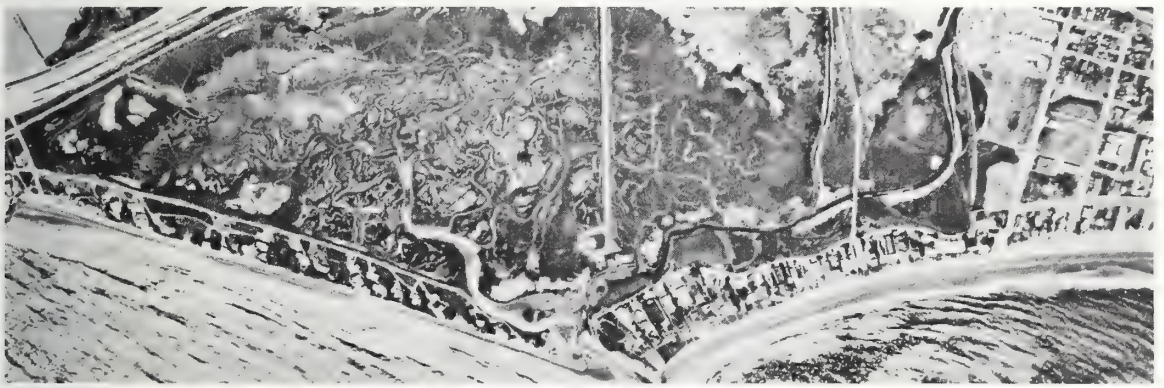


Fig. 32a-d. LOW MARSH VEGETATION CHANGE: 1943-1961.

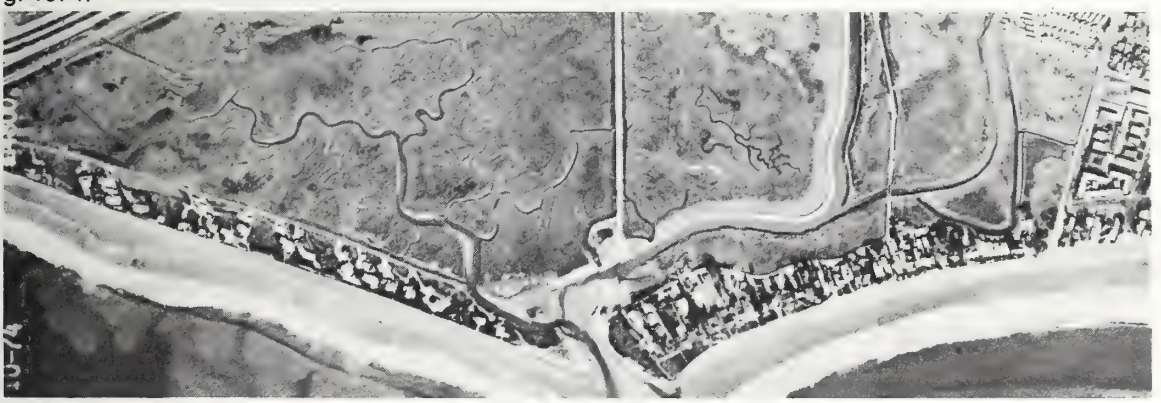
e. 1967.



f. 1968.



g. 1974.



h. 1981.



Fig. 32e-h. LOW MARSH VEGETATION CHANGE: 1967-1981.

extensive desiccation of channels and flats, although permanent flooding is still visible in some channels and in the large flat to the west. This state is probably a summer drought condition and can be compared to portions of Goleta Slough in Santa Barbara County that are permanently diked, fill with rainfall and runoff, remain flooded for an extensive period, and desiccate by mid-summer. In such situations, S. virginica does not occur in the portions of wetland that receive extensive, long-term flooding; but it does grow on the margins of these areas. A similar situation occurs on Devereux Slough, also in Santa Barbara County. This estuary is closed naturally for long periods and is flooded extensively and often for many months by water from runoff and/or storm tides that wash over but do not remove the sandbar. During dry periods it is characterized by extensive unvegetated flats with S. virginica only on the margins and along the central channel.

Although not illustrated in Figure 32, photographs of Carpinteria Salt Marsh for 1962, 1964, and 1965 reveal important information. In March of 1962 the estuary was closed by a sandbar and covered by much water. Sediment deposits occurred at bends in Santa Monica Creek and elsewhere. These features occurred after the storm and flood in February of that year. By February of 1964 the estuary was still closed and flooding of the low marsh was apparent. Revetment was constructed along Sandyland by 1965 to prevent further erosion of the shoreline. Some also was placed at the mouth of the estuary, but this may not have been sufficient to permit regular tidal circulation. Extensive unvegetated flats lined most channels in addition to many small pools and flats that occurred in low areas. S. virginica grew in the higher areas of low marsh.

Flooding in Carpinteria Valley following storms in 1965 and 1966 resulted in the initiation of flood control measures in Carpinteria Salt Marsh. A major channelization project on Franklin and Santa Monica Creeks and their confluence was undertaken in 1966 as an attempt to direct runoff and sediment through the estuary and into the ocean. Figure 32e illustrates not only the channelization project, but also the striking decline of S. virginica in the low marsh and the corresponding

increase in unvegetated mud flats. The loss of S. virginica apparently started along channels and in low areas and gradually extended onto higher elevations of low marsh until much of the vegetation in the western portion of the estuary was eliminated. This reduction of S. virginica is attributed to long-term flooding which killed the plants.

Photographs taken after the initial channelization of streams (Figs. 32f-h) document recovery of S. virginica associated with renewed tidal circulation. As early as 1968 (Fig. 32f) S. virginica was reclaiming habitat it vegetated previous to disturbance. This reclamation apparently occurred in the reverse order of loss of vegetation--that is, from higher elevations of low marsh to the lower limits of growth by S. virginica. The reestablishment was probably largely the result of the expansion of existing colonies of S. virginica. Although germination of seeds and recruitment of seedlings may have contributed to the revegetation of the mudflats, such events are observed in southern California rarely (Zedler, 1982).

Additional channelization measures in 1969 and 1971 were carried out because of new flooding in 1967 and 1969, and because of the continuing threat of property damage in the Carpinteria Valley. Aerial photographs not illustrated in Figure 32 reveal that by 1971 there was a significant return of S. virginica to the barren flats. However, low areas remained unvegetated and appeared as distinctive channels, pools, and small flats. By 1974 (Fig. 32g) extensive areas of low marsh were recolonized, although a fine mozaic of channels and flats remained in the wetland; and by 1976 the low marsh had apparently recovered from the disturbance because it appeared in photographs much as it had in 1947 (Fig. 32b). Figure 32g illustrates wetland conditions for 1981 that are remarkably similar to those before the S. virginica was eliminated from many of the flats. Recovery of the low marsh apparently resulted from restored tidal circulation.

In summary, this series of photographs illustrates a remarkable example of wetland vegetation dynamics. That is, low marsh flats

dominated by S. virginica became nonvegetated flats apparently due to excessive flooding caused by closure of the estuary mouth. Subsequently, S. virginica reclaimed lost habitat when tidal circulation was renewed. As documented by the photographs, decline of S. virginica took place from about 1954 to 1966, a period of 12 years. Revegetation of these same areas took place from about 1967 to sometime between 1974 and 1976, a period of between 7 and 9 years. Thus, long-term flooding can have significant and long-term effects in the lower marsh. However, changes in the vegetation can be reversed with management practices that restore regular tidal circulation.

Zedler et al. (1980) have hypothesized that the closure of an estuary during the growing season can increase productivity of vascular plants beause freshwater runoff decreases soil salinity and because nutrients are retained in the marsh. They also suggest that low rainfall amounts can result in high salinities in a closed estuary, causing a decrease in productivity. As reported herein, however, prolonged periods of flooding also can result in decreased productivity because of a decrease in plant cover when S. virginica dominates low marsh.

Localized Freshwater Runoff - Freshwater marsh often occurs at areas where storm drains and other drainage ways empty into salt marshes (Zedler, 1982). At Carpinteria Salt Marsh several examples illustrate different wetland types that have resulted from this disturbance. Along the northern margin of the estuary beyond the influence of tides, a Palustrine Emergent Wetland in a drainage ditch is characterized by many species with freshwater affinities, including Nasturtium officinale, Scirpus microcarpus, and Typha latifolia, in addition to some species with brackish marsh affinities. Where this wetland drains into the estuary, various forms of Palustrine Emergent Wetland, Palustrine Forested Wetland, and Estuarine Emergent Wetland have developed.

Aerial photographs reveal the sequence and time span covered during the development of this combination of wetlands. Not evident in 1954, brackish marsh apparently dominated by Scirpus californicus, S. maritimus and Typha domingensis extended into salt marsh vegetation along

the northern margin of the estuary between Sand Point and Apple Roads by 1961. Also evident is Palustrine Scrub/Shrub Wetland dominated by Salix lasiolepis. The latter vegetation became Palustrine Forested Wetland by 1967. However, in 1968 new drainage ditches directed runoff from the area eventually reducing the extent of brackish marsh, but apparently not affecting the established stand of S. lasiolepis. The permanence, extent and type of wetland along the northern margin of this estuary is clearly related to the amount and perennial nature of runoff, in addition to the topography of the area and the relationship to tidal inundation. New ditches created in 1983 direct runoff along the north side of the railroad. This recent alteration has already had effects on the composition of Palustrine Emergent Wetland occurring on the south side of the railroad because it no longer receives as much runoff as previously.

Water Pollution - The inflow of contaminated surface water in every drainage entering Carpinteria Salt Marsh is the primary source of pollution in the estuary (County of Santa Barbara, 1985). Nutrients, especially nitrates, and pesticides from agricultural development in the Carpinteria Valley are apparently the source of this pollution. In particular, greenhouses with impervious surfaces that increase runoff, especially during storms, have been identified as the source for nutrient enrichment in the western end of the estuary (Steele, 1982; Stanley and Scholin, 1984).

Page (1979) conducted an evaluation of effluent from drainages along the northwestern margin of Carpinteria Salt Marsh. He listed several lines of evidence that indicate the westernmost drainage is a significant source of poor quality water: 1) low species diversity in this drainage relative to others entering the estuary; 2) low survivorship of salt marsh invertebrate in controlled field transplant and laboratory survivorship experiments; 3) the presence of high levels of nutrients in water of this drainage relative to other creeks and areas of the marsh; and 4) presence of detectable chlorinated hydrocarbon pesticide residues in water sampling. The effect of this polluted

surface water on the majority of the botanical resources at Carpinteria Salt Marsh, as discussed herein, is unknown.

One additional study (Stanley and Scholin, 1984), however, examined the effects of greenhouse effluent in Carpinteria Salt Marsh as reflected by the distribution and growth of an alga, Enteromorpha clathrata. Findings of this investigation include the following: 1) growth of the alga in effluent-enriched sea water always exhibited a greater yield than in sea water without effluent; 2) no other major source of nitrate inputs was identified other than the greenhouse effluent discharge; 3) concentrations of nitrates decreased from point of entry into the estuary to the outlet of the marsh; 4) circulation patterns in the western basin of the estuary (Basin 3) produce higher concentrations of nitrate on the eastern mud flats than those observed on the western mud flats; and 5) wind plays an important role in distributing Enteromorpha over the marsh.

Stanley and Scholin conclude that adequate substrate in Basin 3 in combination with constant input of nitrate-rich water causes dense growth of the alga, but that it is not possible to speculate what effect the enhanced growth rate of Enteromorpha has upon the ecology of Carpinteria Salt Marsh. However, other reports (County of Santa Barbara, 1985) attribute an accumulation of detritus in the western basin to the enhanced growth of algae. Such changes can influence vascular plant growth by increasing the elevation of low areas to levels suitable for growth of Salicornia virginica or other vascular plants.

Improvements in some aspects of water quality in the estuary are predicted (County of Santa Barbara, 1985) because nursery return waters are being redirected through the Carpinteria Sanitary District for treatment instead of flowing directly into the estuary. The County document also reveals that other sources of contaminants in Basin 3 are freeway drains, drainage from a mobile home park, and groundwater infiltration. Furthermore, 3 contaminants found in the estuary (Avoclar, Lindane, and Aldrin) are not used in greenhouses. Analysis of the sources of pollution in Carpinteria Salt Marsh provided the following

estimates of contribution of contaminants: greenhouses--30%; orchards/open fields--50%; perched groundwater--5%; urban areas--10%; other--5%. New studies of water quality in Carpinteria Salt Marsh are being conducted by the Regional Water Quality Control Board (Central Coast Region) as part of the El Estero Improvement and Enhancement Projects and are expected to provide further insight into the problem of pollution in the estuary. A detailed compilation and analysis of water pollution problems and the environmental quality of Carpinteria Salt Marsh has been prepared by the County of Santa Barbara (1985).

Fragmentation of the Estuary - As a result of road construction, flood control projects and infilling, estuaries of southern California are generally divided into basins. The wetlands in these basins may be connected by breaches in berms and culverts under roads, or may no longer receive tidal flushing because of a lack of such connections. Carpinteria Salt Marsh contains examples of many forms of fragmentation, and the vegetation diversity observed today is in part a result of this type of impact. For example, the Palustrine Emergent Wetland in the basin (Basin 1) between Franklin and Santa Monica Creek was once Estuarine Emergent Wetland. Tidal flushing of most of this basin no longer occurs as a result of the construction of berms. Additional fragmentation of the estuarine wetlands is evident in Figure 32a-h.

An analysis of the tidal flushing characteristics of Carpinteria Salt Marsh was conducted recently by Onuf (1984b). He measured the height reached by tidal waters at different locations in the estuary and found that the heights of inundation for sites in the western basin (Basin 3) were 3 cm higher than for sites in the eastern part of the basin east of Apple Road (Basin 2) and 5 cm higher than for sites in the western part of the same basin. He concluded that the reason the western part of Basin 3 is flooded to substantially lower elevations than the rest of the estuary is that the breach in the berm east of the terminus of Apple Road must restrict tidal flushing to areas inside the berm (Basin 2). Onuf also suggests that the wetlands in the western basin (Basin 3), containing natural channels, are apparently flooded to greater heights than sites within the restricted basin (Basin 2) even

though the latter are closer to the mouth of the estuary where maximum tidal flooding would be expected. Because of the low slope across the upper marsh in the vicinity of the alluvial fan deposits of Santa Monica Creek, restriction of tidal flushing, resulting in a decrease in flooding of wetlands, could have an important effect on the vegetation that occurs in the upper marsh in the basin east of Apple Road (Basin 2).

Fragmentation of the estuary may have beneficial effects, however, when berms occur in the form of levees along stream channels. For example, channelized portions of Franklin and Santa Monica Creeks and their confluence occurring in the estuary act as conduits for runoff from the watershed of Carpinteria Salt Marsh. During floods, the runoff is laden with sediment that would be deposited in the estuary, as illustrated by the alluvial fan resulting from the 1914 flood, if it were not for a combination of debris basins that trap sediment and channelized streams with levees that direct flood water through the estuary and into the ocean. Thus, the diked portion of wetland is actually protected from excess sedimentation by marsh fragmentation. This impact contributes to the preservation of estuarine wetlands at Carpinteria Salt Marsh, that would be diminished without controls on the amount of sedimentation and on the direction of flood water runoff.

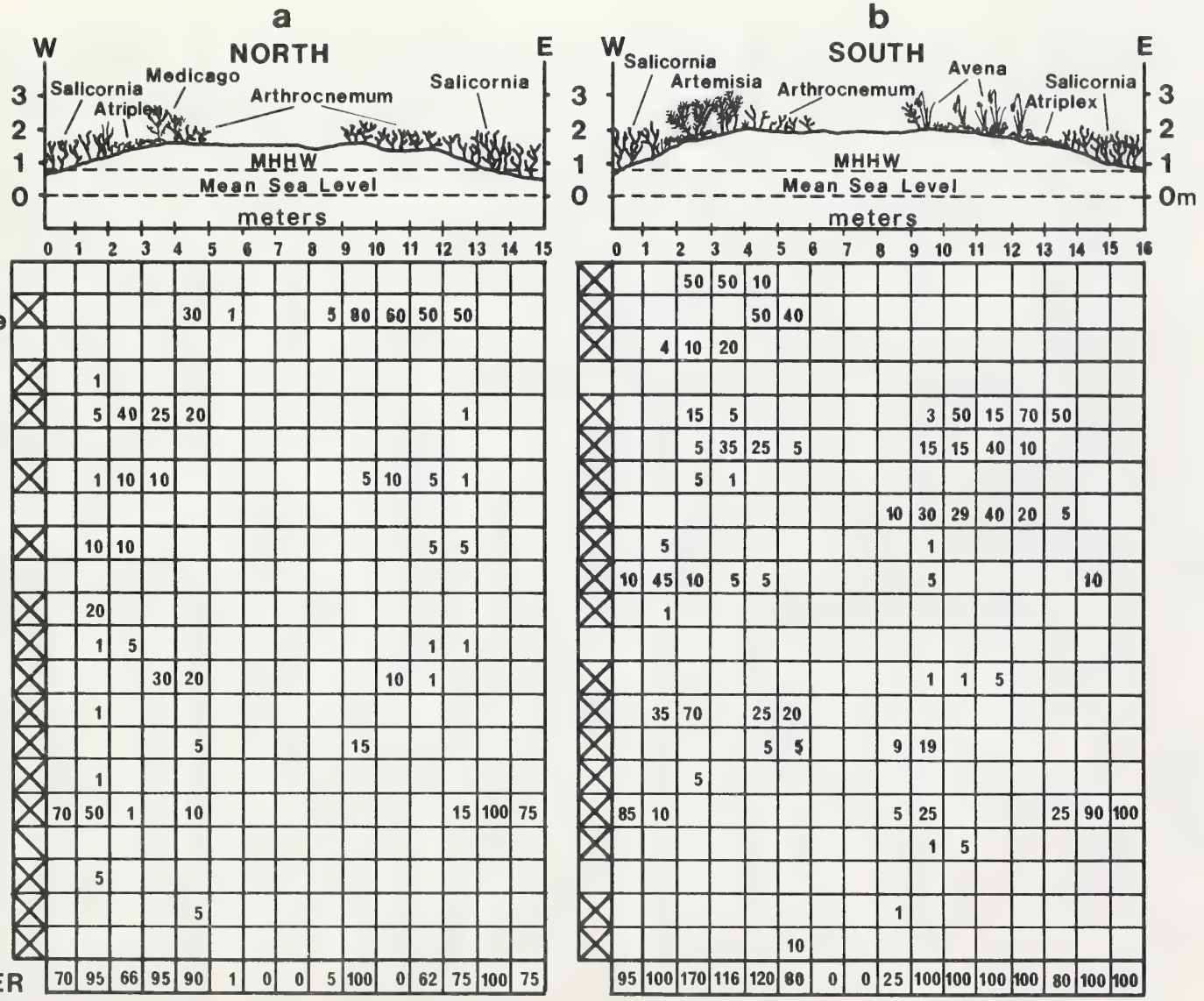
Infilling and Revegetation - As discussed previously (see Catastrophic Short-Term Flooding), the infilling of coastal wetlands, estuaries in particular, often has resulted from the deposition of alluvial deposits during large storms. Lohman et al. (1980) demonstrated the extent of such infilling for Goleta Slough, and the deposition of alluvium in Carpinteria Salt Marsh has been documented herein. However, other forms of infilling have contributed significantly to the loss of wetland habitats. Most infilling in the Late Historic Period is the result of various forms of development associated with the activities of man. As described above, the diking, draining, and filling of the wetlands have resulted in the expansion of the City of Carpinteria across large areas that were once estuarine wetland. Additionally, the construction of the stagecoach trail, railroad, and Old Town during previous historic periods, and the development of Sandyland and

Sandyland Cove, the construction of Apple Road and levees along tidal channels, and the deposition of dredge spoil in flood control easements have caused further conversion of wetland to upland habitats. These impacts are evident in Figures 10a-f and 32a-h.

Revegetation of sites following deposition of fill is of interest from both scientific and management points of view. Understanding the factors that result in the establishment of various forms of vegetation will provide insight into the species that colonize the new habitats and into the management practices that will allow for revegetation by native species that stabilize the man-made structures or habitats. Several factors are considered in the following analysis of the revegetation process: 1) the long-term nature of this disturbance; 2) the various ages, heights, slopes and types of fill; and 3) the frequency of recurring disturbance. Methods of the analysis included the examination of vegetation along eleven transects placed over berms and levees, the observation of spoil sites over a period of several years, and the use of aerial photographs to determine approximate ages of disturbances and the rate of revegetation.

Topographic relief and percent cover of each species present along 9 transects, and vegetation profiles for selected transects (Fig. 33a-c) were analyzed to determine possible relationships between species composition of the revegetated habitats and features of the habitat such as elevation and age. Several interesting phenomena are evident in the profiles illustrated, particularly when they are considered with data observed from photographs. Although Apple Road was constructed sometime between 1943 and 1947 (Figs. 10, 33), and thus is one of the older man-made structures deposited in the low marsh, it does not support extensive Coastal Berm Scrub (Fig. 33 a,b). Instead, it is characterized generally by low marsh vegetation on lower slopes and high marsh vegetation on upper slopes and margins, and by barren flats on the top. This can be attributed to two factors: 1) the top of the berm for Apple Road is rather low in elevation, about 5.0 to 5.6 feet (15.2 to 17.1 dm), and approximates the limits of high marsh; and 2) the center is exposed to repeated episodes of disturbance by vehicles that travel on it to remove

Apple Road North and South

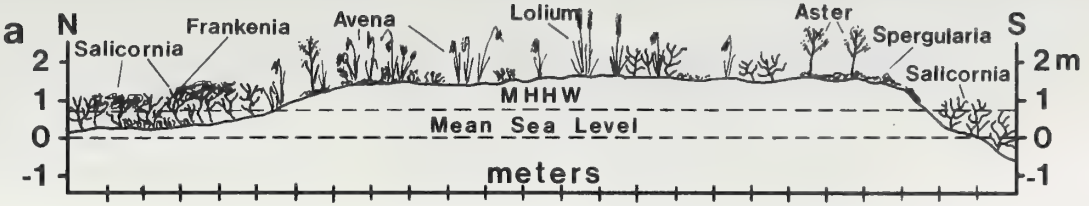


SPECIES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Artemisia californica																	
Arthrocnemum subterminale					30	1			5	80	60	50	50				
Atriplex californica																	
Atriplex patula		1															
Atriplex semibaccata		5	40	25	20								1				
Avena fatua																	
Bromus mollis		1	10	10						5	10	5	1				
Distichlis spicata																	
Frankenia grandifolia		10	10									5	5				
Jaumea carnosa																	
Limonium californicum		20															
Lolium multiflorum		1	5									1	1				
Medicago polymorpha				30	20						10	1					
Monanthochloe littoralis		1															
Parapholis incurva					5					15							
Polypogon monspeliensis		1															
Salicornia virginica	70	50	1		10								15	100	75		
Sonchus oleraceous																	
Spergularia marina		5															
Suaeda calceoliformis					5												
Grass Seedings																	
TOTAL PERCENT COVER	70	95	66	95	90	1	0	0	5	100	0	62	75	100	75		

SPECIES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Artemisia californica			50	50	10												
Arthrocnemum subterminale					50	40											
Atriplex californica		4	10	20													
Atriplex patula																	
Atriplex semibaccata			15	5							3	50	15	70	50		
Avena fatua			5	35	25	5					15	15	40	10			
Bromus mollis			5	1													
Distichlis spicata										10	30	29	40	20	5		
Frankenia grandifolia		5									1						
Jaumea carnosa	10	45	10	5	5						5				10		
Limonium californicum		1															
Lolium multiflorum																	
Medicago polymorpha											1	1	5				
Monanthochloe littoralis		35	70		25	20											
Parapholis incurva					5	5				9	19						
Polypogon monspeliensis			5														
Salicornia virginica	85	10								5	25				25	90	100
Sonchus oleraceous											1	5					
Spergularia marina																	
Suaeda calceoliformis										1							
Grass Seedings						10											
TOTAL PERCENT COVER	95	100	170	116	120	80	0	0	25	100	100	100	100	80	100	100	

Fig. 33a,b. Transects and Vegetation Profiles: Apple Road

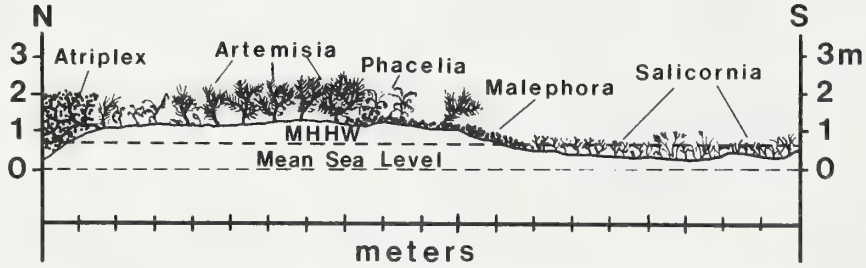
Confluence Santa Monica & Franklin Creeks north bank



SPECIES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Aster subulatus						10	35	10					5		5	5	20	15	5	30	30	25	10			
Atriplex patula									10				5	5			5						10			
Atriplex semibaccata										10																
Avena fatua		5	5		5	25	15	35	25		30	25	10	5	15	25	10	20	5	5						
Bassia hyssopifolia																							5	5		
Bromus diandrus									5		20	5	5													
Cuscuta salina	5	15	10	5	5																					
Cynodon dactylon								10	5	1																
Distichlis spicata								15																		
Euthamia occidentalis									20		5	20			10	15		5								
Frankenia grandifolia	5	30	35	15	10						10	5														
Heliotropium curvassavicum										5			5		5		15						5			
Limonium californicum	5																									
Lolium multiflorum										5			5	35	20											
Malva parviflora									5	5			5	5									5			
Mesembryanthemum nodiflorum										20	10	5														
Oryzopsis miliacea					5	15	5	5																		
Parapholis incurva										5	10	15	15													
Polypogon monspeliensis								10	30	10			15		10		5	10	10	10	40	25				
Ricinus communis								10																		
Salicornia virginica	85	50	50	80	75	10								30	30	40		10	20				5	85	75	
Spergularia marina						40	45	5								15	55		25	50	25	50	15			
Dead Seedlings										30			30	20	5			40	35							
TOTAL PERCENT COVER	100	100	100	100	100	100	100	100	100	91	90	75	100	100	100	100	110	100	100	95	95	100	55	90	75	

Fig. 33c. Transect and Vegetation Profile: Northern Levee along stream confluence

Confluence Santa Monica & Franklin Creeks south bank



SPECIES	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Artemisia californica	30	25	5	25	60	90	80	95		10	60	40	5								
Arthrocnemum subterminale																			20	25	
Atriplex lentiformis breweri	70	25																			
Brassica geniculata			10																		
Frankenia grandifolia			10	20																	
Malephora crocea									80	80	80	100	90	15							
Phacelia ramosissima		25	30	5	10			5	100	50											
Polypogon monspeliensis																	5	80	30	5	5
Salicornia virginica													5	85	100	95	20	70	75	70	
TOTAL PERCENT COVER	100	75	55	50	70	90	80	100	180	140	140	140	100	100	100	100	100	100	100	100	

Fig. 33d. Transect and Vegetation Profile: Southern Levee Along Stream Confluence

dredge spoil from the southern terminus of the road. This disturbance compacts sediment and creates conditions for artificial saline vernal wetlands on the top of the road. Such habitats are found on higher berms that receive repeated disturbance and have saline soils. Apple Road does show some degree of topographic variability along its axis, however, that results in high marsh vegetation occurring at lower elevations (about 5 feet) and some scrub/shrub wetland or Coastal Berm Scrub (e.g., Artemisia californica and Isocoma veneta) at higher elevations (above 5.6 feet). Thus, the elevation and frequency of disturbance of this berm are apparently more important than its age in determining the vegetation even after a period of about 40 years. The silty clay soil used as fill may have some effect on the vegetation that occurs here, but the salinity and moisture content of the soil are apparently the important factors influencing the halophyte and hydrophyte composition of the high marsh vegetation along the berm.

Observations along additional berms or levees result in contrasting vegetation patterns. For example, a transect across a levee along the north side of the confluence of Franklin and Santa Monica Creeks (Fig. 33c) reached elevations in excess of 8 feet (24.4 dm), and illustrated that the top of the berm supported mostly Disturbed Coastal Habitat Vegetation. Although constructed in 1966, this levee has received repeated disturbance in the form of vehicular traffic, maintenance dredge spoil piles, and scraping. These activities have generally prevented the establishment of any vegetation beyond weedy upland types. However, high berms can support other forms of vegetation if disturbance is minimal. Such is the case for the levee on the south side of the confluence of Franklin and Santa Monica Creeks (Fig. 33d), where Coastal Berm Scrub dominates the top of the levee at about 7 feet (21.3 dm). This site may not have been disturbed since 1966 and supports several native shrubs in a dense association. In these two examples both the height of the levee and frequency of disturbance also were important in determining the type of vegetation that occurred. However, without sufficient age, Coastal Berm Scrub would not have had time to grow, particularly if the substrates were saline and had to be leached.

FLORA

The vascular plants of Carpinteria Salt Marsh and vicinity were investigated for this study from 1978 to 1985. Aspects of the study included: (1) examination of herbarium specimens from various institutions for compilation of a list of taxa known to occur in the area, development of background information on the botanical collecting history, and provision of data that may be useful in detecting any changes in the diversity of native plants; (2) field investigations to conduct an inventory of the plants, documented by herbarium voucher specimens; (3) compilation of an Annotated and Illustrated Catalogue of Vascular Plants; and (4) an analysis of the species of special concern, change in floristic diversity, and phytogeographic significance of the estuarine wetlands.

Botanical Collecting History - Carpinteria Salt Marsh, the dunes at Sandyland and Sandyland Cove, and riparian corridors of the Carpinteria Valley have been visited by botanists for at least 90 years, resulting in a valuable combination of historical specimens, specimen label data, and observations. In addition to the interesting natural history of the area, easy access to the habitats from the only coastal route connecting northern and southern California was undoubtedly an important factor attracting botanists and other biologists to the estuary.

The earliest collection from Carpinteria Salt Marsh contains a label from the Herbarium of Lorenzo G. Yates, now deposited in the Herbarium of the Santa Barbara Museum of Natural History (SBM). Dr. Yates was a dentist who came to Santa Barbara in 1881 and was active in the Santa Barbara Society of Natural History (C. Smith, 1976). It is unclear whether the collection of Juncus acutus var. sphaerocarpus from Carpinteria Salt Marsh was collected by Dr. Yates or by Frederick V. Coville, U.S. Department of Agriculture. However, this specimen is important, not only as the earliest collection located during the present study, but also as one of the few regional collections of a

plant now extirpated from these estuarine wetlands and apparently from the entire South Coast of Santa Barbara County.

Few collections were made at Carpinteria Salt Marsh during the first quarter of the 20th Century. However, Mrs. F.D. Oliver collected specimens of at least Atriplex in 1909 and wrote to Alice Eastwood, then Curator of the Herbarium of the California Academy of Sciences (CAS), asking for identifications. Harvey M. Hall, Carnegie Institute of Washington (CI), collected at the estuary in 1919, and deposited specimens of Atriplex and other genera at the University of California, Berkeley (UC) and elsewhere. Some of the specimens are cited in Hall and Clements (1923). Cordylanthus maritimus ssp. maritimus, an endangered species, was first collected at Carpinteria in 1920 by A.L. Grant, whose specimens are contained in the Herbarium of Pomona College (POM), now housed at the Rancho Santa Ana Botanic Garden (RSA). Of additional note are collections made by LeRoy Abrams, Stanford University (DS), in 1904 from bluffs and saline flats at Summerland, a village west of Carpinteria Salt Marsh. Although he may not have collected plants from the estuary, nevertheless he was collecting in the vicinity.

The second quarter of the 20th century included visits to Carpinteria Salt Marsh by many notable collectors. Ralph Hoffmann, Director of SBM (1925-1932), collected numerous specimens from the estuary and dunes between 1925 and 1930. These specimens are housed at SBM, CAS, and POM. While conducting an investigation of the plant fossils at the Carpinteria tar pits east of the estuary in 1927, Herbert L. Mason (UC) collected plants from the estuary and ocean bluffs of the area. Specimens from the Vegetation Map Herbarium of the U.S. Forest Service, deposited at UC, include a few collections by F. Embree made at Carpinteria Salt Marsh in 1935. Locally, the Herbarium of H. & M. Dearing, now distributed at Santa Barbara Botanic Garden (SBBG), UC, and the University of California, Santa Barbara (UCSB), contained specimens collected from the estuary by the Dearings in 1936 and 1937. The dune vegetation also attracted botanists to Sandyland; and H. Copeland in 1938 and G. Ledyard Stebbins in 1939 collected

Malacothrix incana, another species apparently extirpated from the region as a result of development of the coast. Collecting during this period concluded with the initiation (1946) of botanical investigations by Clifton F. Smith, who became Curator of the Herbarium of SBM and an important regional botanist. Many collections made by him and other botanists are cited in his books, A Flora of Santa Barbara (Smith, 1952) and A Flora of the Santa Barbara Region, California (Smith, 1976).

The third quarter of botanical investigation during the 20th Century began at Carpinteria Salt Marsh with efforts by Henry M. Pollard, a private school teacher, the collections of whom are the most significant material for the Carpinteria region. Smith (1976) stated that he left much of the botanical explorations of the Coastal Santa Barbara and Ventura basin regions to Pollard, who visited the estuary, dunes, and riparian corridors at Carpinteria many times between 1950 and 1964. Henry M. Pollard usually collected within walking distance of Santa Barbara, especially along the Southern Pacific Railroad to Carpinteria and Goleta, or on bus trips to the Ventura basin (Smith, 1976). His collections are deposited at CAS, SBBG, RSA, SBM, and UC, and duplicate labels are organized in card files at SBBG. These files were helpful in developing a list of Pollard collections for which searches were made in various herbaria. Of particular note are his collections from the mouth of Carpinteria Creek. These specimens provide the only information on the native wetland plants of this site, the majority of which are now extirpated. Additional collectors at Carpinteria Salt Marsh during this period include students, who later became professional botanists, and local natural historians. They include R.M. Beeks (1951), M.A. Piehl (1962-1963), D. Breedlove (1962), J. Patman (1963), and J. Broughton (1965). Also of note are the following botanists: R.F. Thorne, Curator at RSA, and P. Everett, who made collections in 1965; R. Ornduff, Professor of Botany at UC, who collected Lasthenia glabrata ssp. coulteri at Carpinteria Salt Marsh for his biosystematic survey of the goldfield genus (Ornduff, 1966); and L.R. Heckard, Curator of the Jepson Herbarium, and T.I. Chuang, who surveyed the area (Heckard, personal communication, 1985) for Cordylanthus maritimus ssp. maritimus as part of their taxonomic study

of the bird's-beak genus (Chuang and Heckard, 1973). This quarter century of interest in the botanical resources of Carpinteria Salt Marsh concluded with studies by two UCSB students. Paul Meyers (1974) produced the first checklist of vascular plants (83 species), published in a biological evaluation of the estuary by Macdonald (1976) for the California Department of Fish and Game; and Steven Schwarzbach (1975) listed plants he observed as part of a study for his senior thesis on the natural resources of the estuary.

The remaining botanical collecting history of Carpinteria Salt Marsh and vicinity is characterized by field work conducted from 1978 to the present by the author and his associates. Initially, a field trip was made by the UCSB Botanical Society in July 1978 to examine the botanical resources of the Carpinteria Salt Marsh Reserve, established by the UC Natural Reserve System in 1976. Enthusiasm for the significance of the initial findings resulted in a long term study of the botanical resources, and culminates in this publication.

Summary of the Inventory - Although the actual field study site for this investigation was restricted to Carpinteria Salt Marsh and the immediate vicinity (Fig. 2), it was necessary to extend the treatment of the flora to the historical limits of the estuary (Fig. 8), including the wetlands at the mouth of Carpinteria Creek. This approach permitted a more accurate assessment of the native flora and of the floristic changes that have occurred from the historical to the present botanical investigations.

An Annotated and Illustrated Catalogue of the Vascular Plants (Appendix III) was prepared as a product of the following: (1) an inventory of the flora conducted periodically over the past 7 years; (2) examination of herbarium specimens from previous investigations; and (3) a survey of the literature. The illustrations include selected dominant or characteristic species, or species that are difficult to identify. An index to the catalogue is provided for access to additional information.

A synopsis of the findings (Table VI) indicates that at least 55 vascular plant families containing 153 genera and 252 species are known to occur or have occurred at Carpinteria Salt Marsh, including its historical limits, the sand dunes, and the marsh at Carpinteria Creek. A more meaningful representation of these data is necessary, however, because of the loss of extensive habitat during the 20th Century and the fragmentation of portions of the overall study area. Thus, Table VII provides a breakdown of the numbers according to the following: (1) occurrence in marsh and vicinity, or in creeks; (2) origin, such as native, naturalized, and introduced plants (those non-native plants persistent or short-lived but not reproducing); and (3) species, taxa, hybrids, largest families, and largest genera.

Several interesting proportions are contained among these data. For example, the Asteraceae is the family represented by the most species (48), contributing 19% of the flora; and Atriplex is the genus represented by the most species (7), contributing 3% of the flora. Of particular note is the distribution of the species among native and exotic (naturalized or introduced) species. In the overall study area, only 48% of the observed or collected flora is native to the region, while 52% is exotic. Additional computations reveal that of the total number of species (229) found only at Carpinteria Salt Marsh and vicinity, and not recorded from Carpinteria Creek or the mouth of other local streams, 45% are native to the region while 55% are exotic. These figures tend to be misleading because they do not represent a flora that is composed of an integrated mixture of native and exotic species. On the contrary, the flora is characterized by native species occurring in largely undisturbed wetland habitats; and exotic species, or mixtures of exotic and native species, occurring in disturbed upland habitats or disturbed habitats transitional between upland and wetland conditions. Thus, certain vegetation, such as most Estuarine Emergent Wetlands, contain 100% native species; while others, such as Disturbed Coastal Habitat Vegetation, may contain 100% exotic species.

Distribution of Plants - The distribution of plants by habitats and associations has been discussed in a previous section (see: BOTANICAL

TABLE VI. Synopsis of the Flora of Carpinteria Salt Marsh and Vicinity.

Plant Group	Families	Genera	Species
Class Equisetae	1	1	3
Class Angiospermae			
Subclass Dicotyledoneae	45	117	187
Subclass Monocotyledoneae	9	35	62
TOTALS	55	153	252

TABLE VII. Numbers of Plants by Area, Origin, and Largest Families and Genera.

Category	Carpinteria Salt Marsh and Vicinity			*Creeks only		TOTALS
	Native	Naturalized	Introduced	Native	Naturalized	
Number of Species	104(41%)	113(45%)	12(5%)	16(6%)	5(2%)	252
Number of Taxa	105	113	13	16	5	254
Number of Hybrids	1	1	--	--	--	2
Largest Families (No. of species)						
Asteraceae	26	20		1	1	48(19%)
Poaceae	5	26		1	4	36(14%)
Chenopodiaceae	12	6	--	--	--	18(7%)
Largest Genera (No. of species)						
Atriplex	5	2	--	--	--	7(3%)
Juncus	4	--	--	2	--	6
Rumex	2	4	--	--	--	6
Bromus	1	4	--	--	--	5
Salix	2	--	--	3	--	5
Scirpus	4	--	--	1	--	5
Gnaphalium	3	1	--	--	--	4
Solanum	2	2	--	--	--	4

*incomplete documentation

RESOURCES--Vegetation), and is tabulated in Appendix I, Classification of Upland Vegetation, and in Appendix II, Classification of Wetland Vegetation. Further analysis of the inventory has provided a more complete listing of native plants arranged according to their affiliation with major habitat types (Tables VIII-XI).

For example, native wetland species can be grouped into those plants restricted to or characteristic of estuarine wetlands (Table VIII). At least 38 native species are recorded from the combined estuarine wetlands, as Classified in Appendix II. This list represents the majority of coastal salt marsh species typical of southern California estuaries. Some obvious omissions can be noted either because Carpinteria Salt Marsh is located north of the present range of the species (e.g., Batis maritima) or because appropriate habitats are lacking for some species (e.g., Scirpus robustus, Spartina foliosa). However, in at least one case (i.e., Suaeda esteroa) the range is not a problem--this species reaches its northern limit at Goleta Slough (Ferren and Whitmore, 1983)--and the appropriate high marsh habitat was available to a greater extent in the past (based on aerial photographs) than it is today. One conclusion on the absence of Suaeda esteroa from Carpinteria Salt Marsh is that the population and most of the habitat were destroyed by development before any collections or observations of the species were made by botanists who visited the estuary. A similar situation occurs at Goleta Slough where various forms of development have greatly reduced the population, diminishing it to 3 plants in 1984. Should the Goleta Slough population be destroyed, Mugu Lagoon would become the northern limit of its range.

Another grouping of species includes those of Palustrine Wetlands with freshwater affinity (Table IX). Habitats supporting species of emergent, scrub/shrub, and forested wetland include man-made ditches on the margins of the estuary and marshes that once occurred at the mouth of Franklin and Santa Monica Creeks. Table IX includes 36 native species recorded from the study area. Many other freshwater marsh species are or were possible for the vicinity of Carpinteria Salt Marsh, but have not been observed or recorded. Sparganium eurycarpum is one

TABLE VIII - Native Plants of Estuarine Wetlands at Carpinteria Salt Marsh.

Anemopsis californica
Arthrocnemum subterminale
Aster subulatus var. *ligulatus*
Atriplex californica
A. lentiformis ssp. *breweri*
A. patula ssp. *hastata*
A. watsonii
Baccharis douglasii
B. pilularis ssp. *consanguinea*
†*Carex praegracilis*
†*Chenopodium macrospermum* ssp. *farinosum*
†*C. strictum*
Cordylanthus maritimus ssp. *maritimus*
Cressa truxillensis ssp. *vallicola*
Cuscuta salina
Distichlis spicata ssp. *spicata*
Euthamia occidentalis
Frankenia grandifolia ssp. *grandifolia*
Heliotropium curassavicum ssp. *occulatum*
Hordeum depressum
Hymenolobus procumbens
Isocoma veneta var. *vernonioides*
Jaumea carnosa
†*Juncus acutus* var. *sphaerocarpus*
J. bufonius
Lasthenia glabrata ssp. *coulteri*
Limonium californicum
Monanthochloe littoralis
Salicornia virginica
Scirpus californicus
S. maritimus
†*S. pungens*
Spergularia macrotheca var. *macrotheca*
S. marina
Suaeda calceoliformis
S. californica var. *pubescens*
Triglochin concinna
Typha domingensis

†not observed by the author and possibly extirpated from the study site

TABLE IX - Native Plants of Palustrine Wetlands (Freshwater Affinity) at Carpinteria Salt Marsh

Aster subulatus ssp. *ligulatus*
Atriplex patula
Baccharis douglasii
B. glutinosa
B. pilularis ssp. *consanguinea*
Cardamine oligosperma
Chenopodium macrospermum var. *farinosum*
Cyperus eragrostis
Epilobium ciliatum ssp. *ciliatum*
Equisetum laevigatum
E. hyemale var. *affine*
†*E. telmateia* var. *braunii*
Euthamia occidentalis
Juncus bufonius
J. patens
J. textilis
Lemna gibba
†*L. minor*
Polygonum punctatum var. *confertiflorum*
†*Psoralea orbicularis*
Rubus ursinus
†*Rumex crassus*
R. salicifolius
†*Salix laevigata*
S. lasiolepis
Scirpus californicus
S. maritimus
S. microcarpus
†*S. pungens*
†*Solidago confinis*
Stachys bullata
†*S. rigida* ssp. *quercetorum*
Typha domingensis
T. latifolia
Urtica dioica ssp. *gracilis*
Verbena lasiostachys

†not observed by the author and possibly extirpated from the region

species in this category. Also absent are submerged rooted aquatic species that characterize streambeds and brackish water channels near or at the mouths of coastal streams. Two such species are Potamogeton pectinatus and Zannichellia palustris, common although widely scattered, and both are recorded from habitats associated with Goleta Slough. Because the nontidal streambeds of Franklin and Santa Monica Creek have been channelized and are cement-lined, and the tidal portions are influenced too strongly by marine conditions, habitats that may have supported these plants are no longer present. Ruppia maritima may also occur under similar conditions, but is usually confined to habitats that lack tidal circulation or have poor flushing and are characterized by brackish water. Presently this species occurs at Carpinteria Salt Marsh only in a depression at the southern end of Apple Road.

Of particular interest are records for wetland species from the mouth of Carpinteria Creek (Table X). Because this stream apparently drained historically into Carpinteria Salt Marsh (see PHYSICAL ENVIRONMENT, and HISTORY), the flora of Carpinteria Creek is related to and was perhaps once part of the flora supported presently by the narrowly-defined limits that characterize Carpinteria Salt Marsh today. However, at least 14 native species from a total of 28 collected from the marsh at the mouth of Carpinteria Creek have not been reported from the present vicinity of Carpinteria Salt Marsh. Most of these plants were collected by Henry Pollard in the 1950's from wetlands (palustrine and estuarine) that are limited or no longer occur here. Urbanization of the area surrounding the mouth of Carpinteria Creek, including the development of Carpinteria State Beach Park and the City of Carpinteria, has contributed to the loss of habitat. However, the riverine wetlands and riparian corrider above the mouth of the stream still exist and contain suitable habitat for many native and introduced wetland species. Most of the historic records for plants from Carpinteria Creek document plants more typically freshwater than estuarine in occurrence. This may be due to the larger watershed drained by this stream, and hence more freshwater runoff flowing through the small lagoon and mouth, as compared to the watersheds of Franklin and Santa Monica Creeks that flow into Carpinteria Salt Marsh. Several species recorded from this wetland

(e.g., Potentilla anserina, Scirpus pungens, and Triglochin striata) are common in Estuarine and Palustrine Emergent Wetlands at the mouth of the Santa Maria River where a small lagoon also occurs adjacent to the transitional wetlands. The Santa Maria River occurs in northern Santa Barbara County and supports a great diversity of wetland types that may be similar to some of those once present at Carpinteria Creek.

Another grouping of plants by major habitat type is that for dunes and other sandy upland habitats (Table XI). At least 30 native species have been recorded from the coastal dune and related habitats that extend from the mouth of Carpinteria Creek westward to Sandyland. Outside the immediate study site, these habitats were not examined thoroughly or repeatedly during this investigation. Much of this portion of the coast has been developed or altered or is covered by Carpobrotus edulis, and access to many sites is restricted. Little of the natural dune habitat remains available for colonization by native plants. Five of the taxa known for the area (Table XI) were not observed during this study. Absent from the list are various coastal dune species found elsewhere on the South Coast of Santa Barbara County (e.g. Coal Oil Point Reserve), but for which no records apparently exist from the Carpinteria area. Examples include Abronia maritima, Calystegia soldanella, and Ericameria ericoides.

Extirpated Species - A comparison of historical records (i.e., herbarium specimens and literature) and recent field work has resulted in the compilation of a list of native species (Table XII) that apparently have been extirpated from habitats in the overall study area. These plants have not been observed nor collected recently, and generally occur in habitats that have been impacted by various forms of development. These data reveal that the 27 possibly extirpated species represent 11% of the total of 252 species (26% of the 104 native species) listed in the Catalogue. Additional interpretation of the data includes the following: (1) the 11 species listed for Carpinteria Salt Marsh and vicinity represent 5% of the 229 species and 17% of the 64 native estuarine and palustrine wetland species (Tables VIII and IX) reported from the estuary; (2) the 13 species listed for the mouth of

TABLE X - Native Plants of Wetlands at the Mouth of Carpinteria Creek[1]

*†Amaranthus powellii
*†Berula erecta
Distichilis spicata spp. spicata
*†Eleocharis montevidensis
Epilobium ciliatum ssp. ciliatum
Equisetum hyemale var. affine
E. laevigatum
E. telmateia var. braunii
*†Eragrostis orcuttiana
*†Helenium puberulum
*†Juncus rugulosus
* J. xiphioides
†Lemna minor
*†Mimulus cardinalis
*†Potentilla anserina ssp. pacifica
Ruppia maritima
Salicornia virginica
*†Salix exigua
S. laevigata
*S. lasiandra
S. lasiolepis
*†S. sessilifolia
*†Scirpus americanus
S. maritimus
S. microcarpus
†S. pungens
*†Triglochin striata
Typha domingensis

[1]List includes plants cited in the catalogue and those from recent observations not documented by specimens listed herein. It includes plants of the emergent and scrub/shrub wetlands in the streambed and estuary, but not those on banks and levees of the riparian corridor.
†not observed by the author and possibly extirpated from the sites
*Carpinteria Creek only, not reported from Carpinteria Salt Marsh and vicinity

TABLE XI - Native Plants of Dunes and Other Sandy Habitats at Carpinteria Salt Marsh, Sandyland, Sandyland Cove, and Carpinteria Beach.

Abronia umbellata
Ambrosia chamissonis
A. douglasiana
Amsinckia spectabilis var. spectabilis
Artemisia californica
Atriplex californica
A. lentiformis ssp. breweri
A. leucophylla
A. patula ssp. hastata
Baccharis pilularis ssp. consanguinea
†Camissonia cheiranthifolia ssp. suffruticosa
Carex praegracilis
Chenapodium berlandieri
Descurainia pinnata
†Distichlis spicata spp. spicata
Gnaphalium spp.
Heliotropium curassavicum ssp. occulatum
Hemizonia fasciculata
Heterotheca grandifolia
Isocoma veneta var. vernonioides
Juncus textilis
Lotus scoparius
Lupinus arboreus
L. succulentus
†Malacothrix incana var. incana
†M. incana var. succulenta
M. saxatilis var. tenuifolia
Phacelia distans
P. ramosissima var. suffrutescens
Solanum douglasii
Scrophularia californica
†Stephanomeria exigua ssp. coronaria

†not observed by the author and possibly extirpated from the region
*observed recently and not listed in the catalogue

TABLE XII. Species Possibly Extirpated From the General Study Area and Vicinity.

Plants	Past Distribution in Study Area*			Present Distribution	
	Carpinteria Salt Marsh & Vicinity	Carpinteria Creek (Mouth)	Dune Habitats	Present Elsewhere on South Coast†	Extirpated from South Coast†
Amaranthus powellii		1958		✓	
Amsinckia spectabilis			1960	rare	
Atriplex leucophylla			1925	✓	
Berula erecta		1957		rare?	?
Carex praegracilis	1931		1931	✓	
Chenopodium macrospermum	1952			?	
C. strictum	1963			?	
Eleocharis montevidensis		1958		✓	
Eragrostis orcuttiana		1958		✓	
Helenium puberulum		1957		✓	
Juncus acutus	1958				✓
J. rugulosus		1958		✓	
Lemna gibba	1958			✓	
Malacothrix incana			1939		✓
Mimulus cardinalis		1958		✓	
Potentilla anserina		1955		?	
Psoralea orbicularis	1955			?	
Rumex crassus	1958			rare	
Salix exigua		1959		✓	
S. sessilifolia		1959		rare?	?
Scirpus americanus		1955		rare	
S. pungens	1930	1957		✓	
Solidago californica	1958			✓	
S. confinis	1959				✓
Stachys rigida	1958			rare?	?
Stephanomeria exigua[1]			1958	rare?	?
Triglochin striata		1937			✓

*last collection date given

†South Coast of Santa Barbara County

[1]S. e. spp. coronaria

Carpinteria Creek represent 46% of the native wetland species documented for the site; and (3) the 4 species listed for dunes and other sandy habitats represent 13% of the 30 native species documented from these habitats.

This considerable change in the flora has been specific in location and habitat. For example, the majority of species extirpated from the vicinity of Carpinteria Salt Marsh have been those characteristic of palustrine wetlands with freshwater or slight brackish affinity occurring on the northern margin of the estuary and at the mouths of Franklin and Santa Monica Creeks (e.g., Psoralea orbicularis, Rumex crassus, Solidago confinis, and Stachys rigida), or characteristic of wetlands transitional between the dune habitats and the marsh on the southern margin of the estuary (e.g. Carex praegracilis and Scirpus pungens). Likewise, plants apparently extirpated from the mouth of Carpinteria Creek are those more characteristic of palustrine or riverine wetlands (e.g. Berula erecta, Helenium puberulum, and Mimalus cardinalis) rather than estuarine wetlands. However, estuarine species such as Juncus acutus and esturine or palustrine species such as Potentilla anserina and Triglochin striata also are among those extirpated from the area. The flora of dune habitats also is diminished, and because this flora has not been as thoroughly investigated as that of the wetlands, the number of extirpated species is probably underestimated.

The last dates of collection for extirpated species further reveal aspects of impacts to the flora. For example, all but two dates occur before 1960, and none occur after 1963. Unfortunately, a number of the plant records are based upon single collections made by Henry Pollard in the 1950s. However, extensive alteration of habitats continued from previous periods through the 1960s and probably resulted in the loss of habitat that supported species no longer occurring at Carpinteria Salt Marsh, Carpinteria Creek, and on dunes. If it were not for the extensive collections of Hoffmann in the 1930s and of Pollard in the decades that followed, we would have little knowledge of the composition of the original flora of the area. While many of the species extirpated from the Carpinteria Salt Marsh area are found currently elsewhere on the

South Coast of Santa Barbara County, a number of these are rare, occurring at only one or a few localities. At least 4 and perhaps as many as 6 species no longer occur in this region (Table XII).

Regionally Rare Species - In addition to those species apparently extirpated from the Carpinteria Salt Marsh area, 13 species are considered herein as rare plants of estuarine and related palustrine wetlands along the South Coast of Santa Barbara County (Table XIII). Twelve of these are known to occur presently at Carpinteria Salt Marsh and vicinity (Fig. 34). This list is a combination of plants restricted to salt marshes, widespread in palustrine wetlands, California endemics, and species widespread in North America. However, all are presently rare in the South Coast region because of restricted habitat.

Anemopsis californica (Yerba Mansa), a perennial herb, is widespread in California, southwestern United States, and Mexico (Munz, 1959). It is known from a few localities in northern Santa Barbara County (e.g., Santa Ynez River, Santa Maria River, La Purisima). Along the South Coast of Santa Barbara County it apparently occurs presently only at Carpinteria Salt Marsh, where it is uncommon but locally abundant at the western end of the estuary, at a seep east of Carpinteria Creek, and at Pershing Park (D. Smith, personal communication, 1985).

Arthrocnemum subterminale (Parish's Glasswort), a suffrutescent perennial, occurs from San Francisco Bay and the San Joaquin Valley south to Mexico (Munz, 1959). In southern California, it is restricted to coastal salt marshes, and on mainland Santa Barbara County is recorded only from Carpinteria Salt Marsh and Goleta Slough. Because it is characteristic of high marsh estuarine wetland, A. subterminale has been affected by developments that occur on this habitat, particularly at Goleta. At Carpinteria it is occasional to common and occurs in middle marsh vegetation, in a monotypic stand marking the lower limit of high marsh along the alluvial fan of Santa Monica Creek, and scattered in various forms of high marsh vegetation along the margins of the estuary. When present it may be scattered to locally abundant.

Atriplex watsonii (Matscale), a prostrate perennial herb, occurs in various coastal habitats from Morro Bay south to Baja California, and is reported from the California Islands (Munz, 1959; Smith, 1976). In recent years only a few individuals of this species have been observed in Goleta Slough, where A. watsonii is threatened with extirpation because of loss of appropriate high marsh habitat. Elsewhere on the South Coast it is known only from Carpinteria Salt Marsh where a few plants occur in high marsh vegetation along Apple Road and Sand Point Road. Loss of high marsh at Carpinteria has contributed undoubtedly to a decrease in the species occurrence here.

Cordylanthus maritimus ssp. maritimus (Salt Marsh Bird's-Beak), an erect annual herb, reaches its northern limit at Carpinteria Salt Marsh and is an endangered species (USDI, 1980; CDFG, 1984; Smith and York, 1984). It will be treated in detail below, under the heading Endangered Species.

Hordeum depressum (Alkali Barley), an annual grass, is usually characteristic of alkaline or saline soils and is widespread in western North America (Munz 1959; Hitchcock and Chase, 1950). The occurrence of this species was not substantiated for the South Coast until recently (Ferren and Rindlaub, 1983). Although it is now recorded from estuaries at Carpinteria, Goleta, and Devereux, it is uncommon to rare at each estuary and is usually restricted to high marsh or transitional wetlands with open, desiccated substrates.

Hymenolobus procumbens, a diminutive annual mustard, is widespread in North America and elsewhere (Munz, 1959). It is native to coastal and interior habitats of Santa Barbara County; and although reported only a few times from the region (Smith, 1976), it is apparently occasional on moist or desiccated, saline, sandy, or rocky soils. It is reported herein for the first time from Carpinteria Salt Marsh--this is also the first record of the plant from the South Coast of Santa Barbara County. At Carpinteria it grows commonly to abundantly in open high marsh or transitional wetland vegetation with moist saline soil on the alluvial fan formed by Santa Monica Creek. It is one of several native

TABLE XIII. Occurrence (Past and Present) of Regionally Rare Species at Carpinteria Salt Marsh and Other Estuaries.*

Plants	Estuaries and Related Wetlands				
	Carpinteria	Santa Barbara†	Goleta	Devereux	Small Estuaries
Anemopsis californica	✓	✓			
Arthrocnemum subterminale	✓		✓		
Atriplex watsonii	✓	✓	✓		
Cordylanthus maritimus	✓				
Hordeum depressum	✓		✓	✓	
Hymenolobus procumbens	✓				
Juncus textilis	✓				
Lasthenia glabrata	✓	✓	✓		
Limonium californicum	✓		✓		
Monanthochloe littoralis	✓		✓		
Suaeda calceoliformis	✓	✓	✓	✓	
Suaeda esteroa	?		✓		
Triglochin concinna	✓	✓	✓		

* not including those plants listed in Table XII as possibly extirpated from the study area.
† historic estuary no longer occurring in the City of Santa Barbara.
? not reported from Carpinteria Salt Marsh but still occurring at Goleta Slough.

annual species (e.g., Juncus bufonius, Hordeum depressum, Lasthenia glabrata, Suaeda calceoliformis, Spergularia marina) that grow among scattered perennial salt marsh species. These plants apparently respond to winter rainfall, and generally are spring and early summer flowering species. This association generally occurs in high marsh areas impacted by development, and is now rare as a coastal salt marsh association.

Juncus textilis (Basket Rush), a tall perennial rush, occurs in California from Santa Barbara County south to the San Bernardino Mountains (Smith, 1976). Along the South Coast of Santa Barbara County it is uncommon to rare and may currently grow only in the vicinity of Carpinteria Salt Marsh, for example, in a depression and along a road bank near the intersection of US Highway 101, Santa Claus Lane, and

FIG. 34. REGIONALLY RARE OR ENDANGERED SPECIES: HABITATS AND OCCURRENCE*

- LEGEND -

No.	Plant	Estuarine High Marsh			Northern Margin
		AFD[1]	SD[2]	OBD[3]	
1	Anemopsis californica				✓
2	Arthrocnemum subterminale[4]	✓	✓	✓	
3	Atriplex watsonii		✓	✓	
4	Cordylanthus maritimus		✓	✓†	✓†
5	Hordeum depressum	✓		✓	
6	Hymenolobus procumbens	✓			
7	Juncus textilis				✓
8	Lasthenia glabrata	✓	✓		
9	Limonium californicum[5]	✓	✓	✓	✓
10	Monanthochloe littoralis[6]	✓	✓	✓	✓
11	Suaeda calceoliformis[7]	✓		✓	
12	Triglochin concinna			✓	✓

*only those species present and not extirpated from the area
†exceptionally rare occurrence
[1]alluvial fan deposits
[2]sand deposits
[3]old berm deposits
[4]scattered individuals generally not shown (particularly those on berms)
[5]widespread and not shown here (generally in middle and upper marsh)
[6],[7]scattered individuals or colonies on berms generally not shown

Fig. 34. REGIONALLY RARE

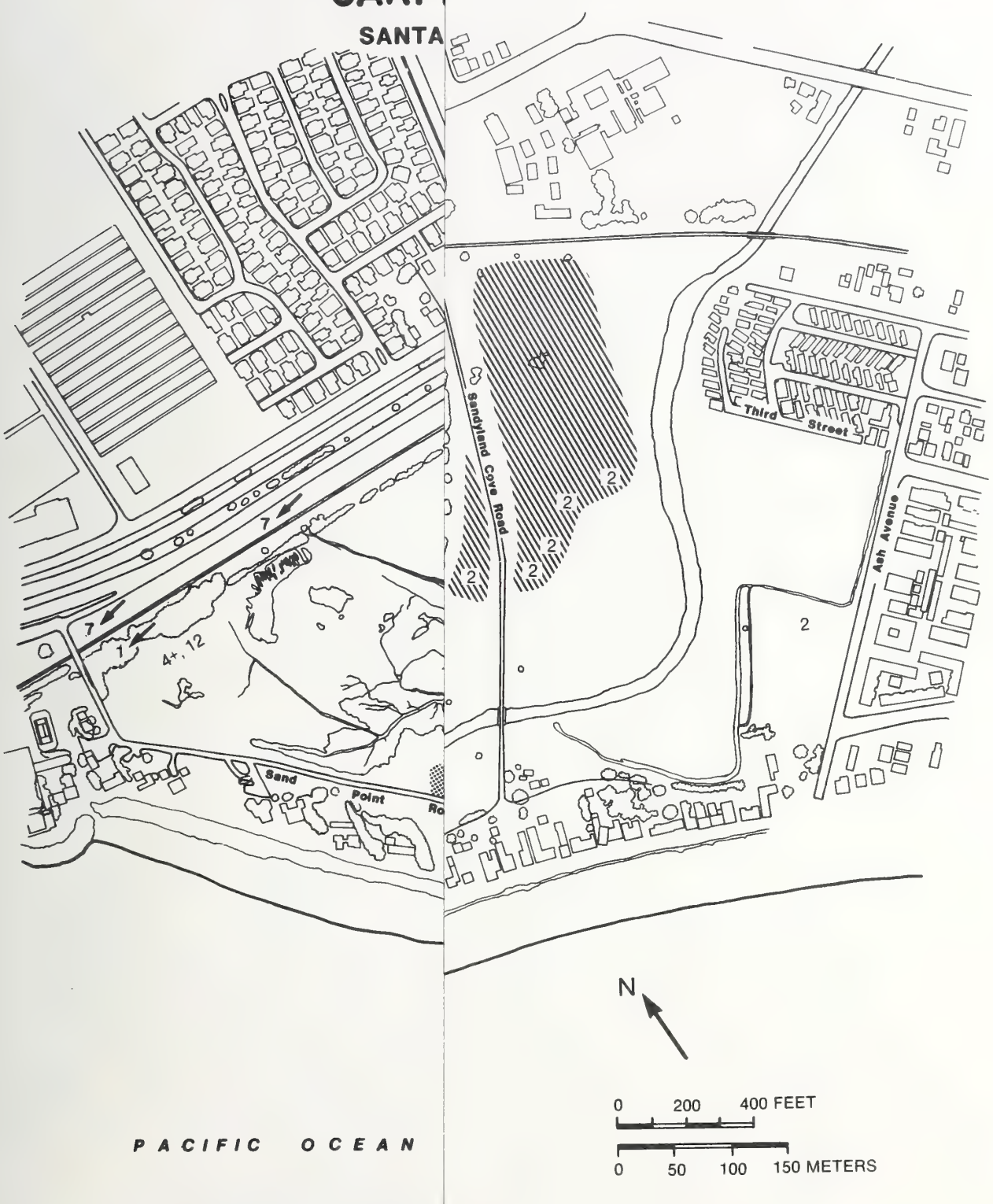
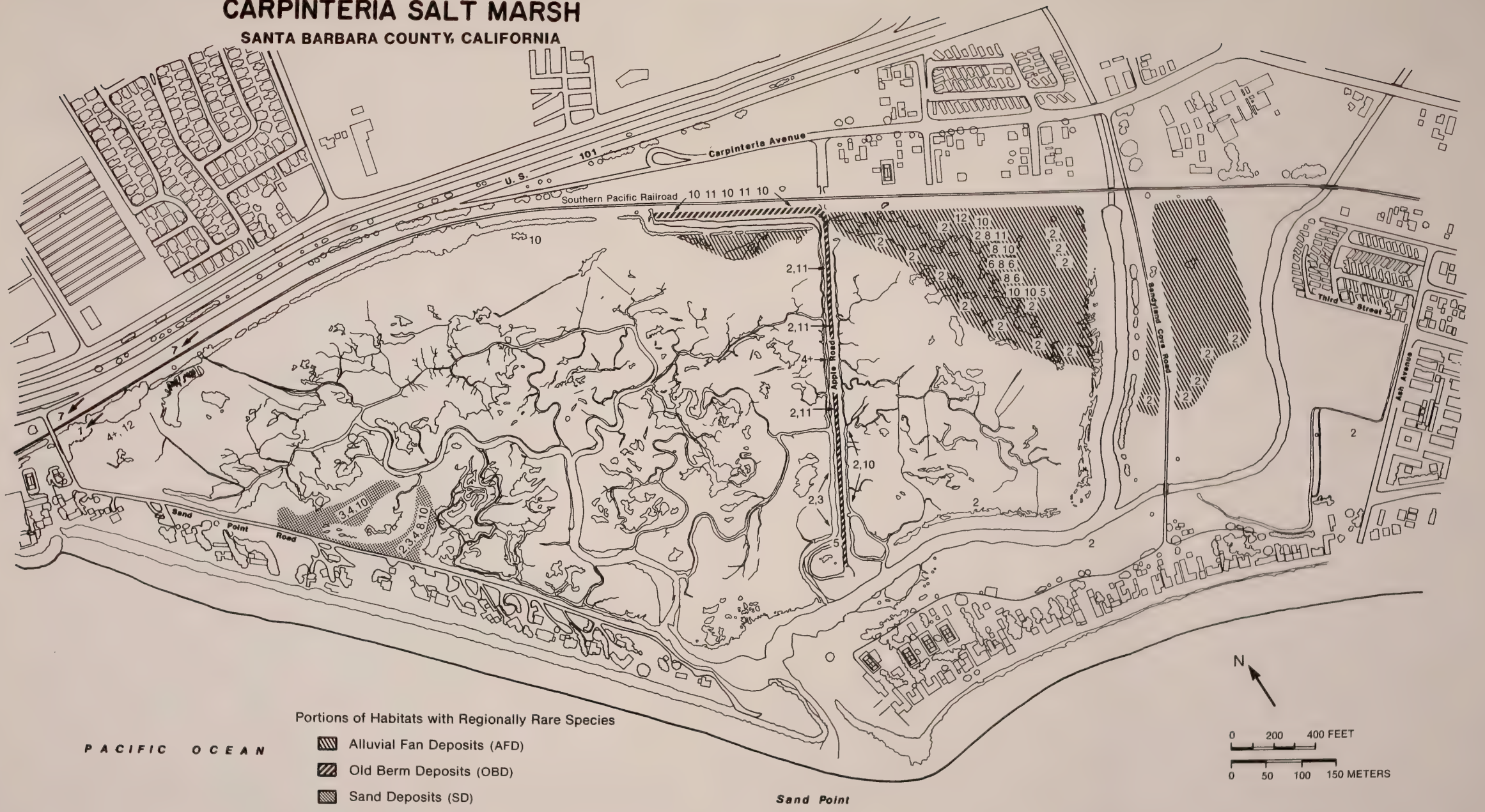


Fig. 34. REGIONALLY RARE OR ENDANGERED SPECIES: HABITATS AND OCCURRENCE



Sand Point Road. Juncus textilis and Anemopsis californica are apparently both examples of plants that have survived the destruction of palustrine and transitional estuarine wetlands having freshwater or brackish characteristics. Other species with this distribution are apparently extirpated from the area (Table XII), while some still characterize the remaining habitats (Table IX). Both species are more common of various coastal wetlands in northern Santa Barbara County.

Lasthenia glabrata ssp. coulteri (Salt Marsh Daisy), an annual herb (see cover photographs and Fig. 48), occurs in salt marshes, vernal pools, and winter-wet alkali flats from Kern County to southern San Diego County and Santa Rosa Island (Ornduff, 1966). Along the South Coast it has been collected from estuaries at Goleta (Ferren and Rindlaub, 1983), Santa Barbara, and Carpinteria (Smith, 1976). It is restricted to margins of desiccated saline depressions in diked portions of Goleta Slough, and occurs in high marsh vegetation adjacent to dunes along Sand Point Road and on alluvial fan deposits adjacent to Santa Monica Creek. Both sites have been disturbed in the past probably resulting in a loss of habitats for the species. Ornduff (1966) states that L. glabrata ssp. coulteri "...[was] formerly common in coastal salt marshes, but [is] rapidly disappearing from these localities." Today it is uncommon at Carpinteria Salt Marsh, but is scattered to locally abundant when it occurs.

Limonium californicum, a perennial herb, is restricted to coastal salt marsh and coastal strand habitats and occurs from Humboldt County, California, to Baja California, Mexico (Munz, 1959). Regionally, it is reported only from Goleta Slough and Carpinteria Salt Marsh (Smith, 1976; Ferren and Rindlaub, 1983). It is occasional to common at both estuaries; and because L. californicum occurs in middle as well as high marsh habitats, it has not been affected by marsh alteration as much as the more narrowly-restricted species.

Monanthochloe littoralis (Salt Cedar), a trailing perennial grass, occurs from Goleta Slough south to Baja California and Santa Catalina Island, and east to Florida and Cuba (Munz, 1959). At Goleta Slough it

is reduced to a single colony, and the cause of this reduction in numbers of plants is apparently the destruction of high marsh habitat. At Carpinteria Salt Marsh, M. littoralis occurs on native substrates, such as the high marsh adjacent to Sand Point Road, and on old berm deposits such as Apple Road. Impacts by development in high marsh habitats undoubtedly have caused a decrease in the occurrence of this species. However, creation of unintentionally appropriate low berm habitat when Apple Road was constructed has permitted M. littoralis to colonize areas that otherwise would not occur. Currently, it is occasional at the salt marsh, but may be common to abundant when it occurs.

Suaeda calceoliformis (Sea-Blite), an annual herb, is widespread in North America, occurring in various alkaline and saline coastal or interior wetland habitats (Munz, 1959; McNeill, Fassett, and Crompton, 1977). Regionally, the plant is recorded only from the vicinity of estuaries at Devereux, Goleta, and Carpinteria. Suaeda calceoliformis was apparently common in transition wetland habitats of alluvial fans occurring at the mouths of streams that emptied into estuaries. Like Lasthenia glabrata ssp. coulteri and others, it grows on open, moist or desiccated, saline soils that are leached by winter rains. With the loss of most of this habitat at Goleta Slough and Carpinteria Salt Marsh, the species would have been nearly eliminated if it were not for its ability to grow on poorly drained saline soils of berms and dredge spoil piles. At Carpinteria Salt Marsh, S. calceoliformis occurs occasionally on both native (alluvial fan) and berm (Apple Road) substrates, where it may be scattered to locally common. Thus, it is found in Estuarine Emergent (high marsh) and Palustrine Emergent (saline vernal) Wetlands, but prior to disturbance may have occurred only in high salt marsh vegetation.

Triglochin concinna (Seaside Arrow-Grass), a perennial herb, is restricted to coastal salt marshes from British Columbia, Canada, south to Baja California, Mexico (Munz, 1959). It has been reported regionally from estuaries at Goleta, Santa Barbara, and Carpinteria. Recently, only one plant was located during a survey of Goleta Slough (Ferren and

Rindlaub, 1983). Numerous plants were observed during the course of field work for this study, but grew only in two colonies in Carpinteria Salt Marsh. This species occurs apparently in low, wet habitats within several types of estuarine wetlands, and thus is not restricted to high marsh vegetation where impacts are more widespread. The habitat variability shown by T. concinna is not consistent with its scarcity at Goleta Slough and Carpinteria Salt Marsh, where more suitable habitats appear to exist than are colonized. At Carpinteria Salt Marsh, however, both colonies occur along the northern margin of the estuary and perhaps reflect a preference for areas influenced by freshwater runoff and periods of standing water. As discussed previously, the northern margin of the estuary is another area where numerous impacts associated with development have occurred, reducing the extent of wetlands transitional between estuarine and palustrine types. Thus the limited occurrence of T. concinna also might be related to habitat destruction.

Endangered Species - Carpinteria Salt Marsh is the northwestern limit of occurrence for Cordylanthus maritimus ssp. maritimus (Chuang and Heckard, 1973; Ferren and Rindlaub, 1983; Howald et al. 1985), an endangered annual herb restricted to coastal salt marshes (see cover photographs and Fig. 72). It is known historically from many estuarine wetlands extending south to Baja California Norte, Mexico (Chuang and Heckard, 1973), including 34 localities at 10 estuaries in southern California and 6 localities in Mexico (USFWS, 1983a). Since 1975 it has been observed at 6 of these estuaries and one new site in Ventura County, but apparently has been extirpated from the other localities (USFWS, 1983a). Concern for the status of this plant resulted in it being listed as endangered at the Federal (USDI, 1980) and State (CDFG, 1984) levels, and as rare and endangered by the California Native Plant Society (Smith and York, 1984).

The ecology of C. maritimus ssp. maritimus has been investigated by several authors (Chuang and Heckard, 1973; Murphey et al., 1981; Vanderwier, 1983; Vanderwier and Newman, 1984), and was summarized recently (USFWS, 1983a). These investigators report that in general it occurs in Irregularly Flooded Estuarine Emergent Wetland (both middle

and high marsh) and diked portions of estuarine wetlands now classified as Palustrine Emergent Wetland. It is usually associated with Salicornia virginica, Distichlis spicata, Frankenia grandifolia, Jaumea carnosa, Arthrocnemum subterminale and Atriplex watsonii. Open substrate is an important factor for successful seedling establishment and such conditions occur in sandy areas of high marsh characterized by scattered perennial species. Cordylanthus maritimus ssp. maritimus occurs commonly in large almost monospecific colonies as well as in smaller less dense groups and as scattered individuals. It also occurs in narrow elevational bands within marshes, representing sites where seeds are dispersed and where germination and seedling and establishment are possible (USFWS, 1983a). Freshwater conditions are apparently important for germination, and in some habitats that are impounded, seasonal flooding followed by desiccation also results in germination and seedling establishment. This species is a facultative root parasite and is capable of various interspecific as well as intraspecific forms of parasitism, apparently permitting it to survive the hot, dry conditions of summer when most other annuals have completed their life cycle (Vanderwier and Newman, 1984).

Observations on C. maritimus ssp. maritimus at Carpinteria Salt Marsh are consistent with information cited above. For example, this plant is restricted almost entirely to high marsh occurring on sand deposits in the estuary on the northern margins of Sandyland and Sand Point Road (Fig. 34). These deposits were probably formed by storm generated waves that washed over the dunes historically and produced sandbars in the marsh. Presumably, this form of habitat existed along the entire length of the southern margin of Carpinteria Salt Marsh before urbanization caused the destruction of much of the habitat transitional between coastal dune and salt marsh. As discussed previously (see HISTORY: Late Historic Period), even the existing habitat was impacted when portions were apparently excavated for the construction of a new berm for Sand Point Road. The remaining sand deposits support the most diverse assemblage of native salt marsh species of any site at Carpinteria Salt Marsh (see Appendix II: Classification of Wetlands); and include C. maritimus ssp. maritimus as (1) scattered

individuals, small groups of individuals, or large colonies on the relatively flat top of the deposit, (2) scattered individuals on gently sloping habitat adjacent to Sand Point Road, and (3) linear colonies along the sand deposits in the vicinity of mean higher high water. Total numbers of individuals remained about 2300 from 1979 to 1983; however, only about 400 were observed in 1984, possibly correlated with the lack of any significant rain that year after December 25, 1983.

Additional occurrences of the plant are rare, but have been observed by the author at the west end of the estuary (3 plants) in a low area dominated by Triglochin concinna and having an open clay substrate; and along Apple Road (one plant) in the vicinity of mean high tide. These sightings record what are probably nonpersistent establishments of the species at locations where germination and growth are possible but not favored for multiple generations. Historically, other colonies of C. maritimus ssp. maritimus have occurred at Carpinteria Salt Marsh; and were documented by herbarium specimens collected by Henry M. Pollard from the border of the salt marsh along the Southern Pacific Railroad (in bed of Frankenia, not common, 21 Sep 1956, DS, RSA, UC), and by J. Patman from near the center of the estuary (one small patch, 22 Aug 1963, SBBG). Pollard noted in his card file (date?) that this species was no longer present on the north side of the estuary, but was present on the south side fronting dunes and beach. Both of these occurrences may be similar to the other observations and perhaps document only short-term establishment. Nevertheless, from the first collection at Carpinteria Salt Marsh (Sandyland, A. Grant 1669, 20 Aug 1920, POM) to the present, C. maritimus ssp. maritimus is recorded for a period of 65 years, apparently representing an annual reestablishment of the species at the Sand Point Road locality and rare occurrences of small groups of individuals elsewhere in the salt marsh.

The habitat value of Carpinteria Salt Marsh for C. maritimus ssp. maritimus has been recognized by various agencies and institutions (e.g. City of Carpinteria, 1980; Kennedy, 1980; County of Santa Barbara, 1979, 1982). Likewise, a recovery plan (USFWS, 1983a) and proposal for management (USFWS, 1985) both consider future goals for monitoring and

managing habitat at Carpinteria Salt Marsh specifically for this endangered species. Thus Carpinteria Salt Marsh will probably play an important role in the investigation of the biology of C. maritimus ssp. maritimus, and in the implementation of plans to protect its present range and perhaps to recover portions of its historical occurrence.

Phytogeographic Significance - Estuaries of the Santa Barbara region can be grouped into three major types: (1) large estuaries occurring in structural basins; (2) estuaries occurring at the mouths of rivers; and (3) small estuaries occurring at the mouths of streams (Mulroy et al., 1984; Howald et al., 1985). Each of these has a characteristic environmental setting that supports a distinctive flora.

Carpinteria Salt Marsh and Goleta Slough are examples of regionally large estuaries occurring in structural basins that have developed as a result of faulting and folding of sedimentary rocks (see PHYSICAL ENVIRONMENT: Geology). Both occur just north of major faults, lie in basins that serve as sediment traps for streams that drain the steep slopes of the Santa Ynez Mountains, are more strongly influenced by marine water than by freshwater runoff, and have undergone periods of closure caused by the development of sand spits across their mouths. Goleta Slough is floristically unique because it is the northwesternmost large estuary in the southern California region, and as such provides habitat for at least 2 coastal salt marsh species (Atriplex watsonii and Suaeda esteroa) that reach their northern limits in the estuary. Similarly, Carpinteria Salt Marsh, occurring southeast of Goleta Slough, is the northern limit of at least one coastal salt marsh plant (Cordylanthus maritimus ssp. maritimus). Both estuaries are typical of those in southern California, and are characterized by vegetated flats dominated by Salicornia virginica. However, they lack Spartina foliosa, a species that occurs in estuaries with greater tidal prism such as those to the south at San Diego Bay, Anaheim Bay, and Mugu Lagoon (Zedler, 1982), and those to the north in the San Francisco Bay area. Carpinteria Salt Marsh is notable among southern California estuaries for having remnants of natural, relatively undisturbed, alluvial fan and sand deposits that support associations of typical, rare, and

endangered vascular plant species, found rarely today because of extensive impacts to coastal wetlands.

SUMMARY

Carpinteria Salt Marsh contains both upland habitats (e.g., dunes, portions of alluvial fans, berms, roadsides, and dredge spoil) and wetland habitats (e.g., intertidal, subtidal, and nontidal vegetated and nonvegetated flats, ditches, banks, slopes, and depressions). Upland vegetation includes disturbed coastal habitats, dune habitats, grassland, coastal scrub, and cultivated associations. Wetland vegetation is characterized largely by many forms of Estuarine Emergent Wetland, and some palustrine wetland associations in non-tidal areas. Estuarine wetlands include low, middle, and upper marsh types, although the majority of the salt marsh is dominated by Salicornia virginica in low marsh areas. Rare high marsh vegetation occurs on alluvial fan and sandbar deposits and slopes of low berms. Saline vernal wetlands of palustrine areas provide habitats for some high marsh species that are now uncommon because of the loss of estuarine wetlands on the margins of the estuary. Vascular plant biomass and productivity were found to be similar at various sites measured in the estuary even though different elevations occurred. This is attributed to the occurrence of S. virginica which may not be sensitive to variations in tidal inundation.

Vegetation of Carpinteria Salt Marsh is influenced by many physical factors, including topography, water and salinity regimes, substrate, climatic conditions, and disturbance. Both natural and man-made disturbances have had major impacts on the botanical resources of the estuary and vicinity. For example, catastrophic short-term flooding has resulted in the deposition of tons of sediment in the form of alluvial fans (e.g., the 1914 flood). This type of flooding also has caused the alteration of stream courses, and the use of emergency flood control measures that resulted in the deposition of additional sediment into wetlands. Other disturbances include the following: 1) long-term

flooding of low marsh areas due to mouth closure, resulting in the death of extensive wetland vegetation; 2) localized freshwater runoff that provides habitats for both freshwater and brackish water vegetation along the northern margin of Carpinteria Salt Marsh; 3) water pollution primarily from greenhouse runoff that includes nitrates and pesticides, has enhanced the growth of an alga, Enteromorpha clathrata, and has increased accumulation of detritus; 4) fragmentation of the estuary by the construction of berms, roads, and levees has resulted apparently in the decreased flooding of some wetlands and the loss of others; and 5) the construction of roads, the filling of marsh for development, and the infilling of wetlands from natural causes such as the development of alluvial fans. Revegetation of the disturbed or newly created habitats is of great interest for possible marsh enhancement projects, and observations revealed that height and slope of habitats influenced the vegetation that has developed after disturbance.

The flora of Carpinteria Salt Marsh has been of interest to botanists for at least 90 years. Historical records and collections have made possible a reconstruction of the floristic diversity of the estuary and vicinity before many impacts of urbanization occurred. A synopsis of the findings has shown that at least 55 vascular plant families containing 153 genera and 252 species are known to occur or have occurred at Carpinteria Salt Marsh, including its historical limits, the sand dunes, and the marsh at Carpinteria Creek. Of those at Carpinteria Salt Marsh, 104 species (45% of the flora) are native. Eleven species listed for Carpinteria Salt Marsh and vicinity are possibly extirpated, representing 17% of the 64 native wetland species. Additionally, 13 species listed for the mouth of Carpinteria Creek also are possibly extirpated, representing 46% of the native wetland species. Twelve species growing presently at the estuary are considered as regionally rare plants; and one plant, Cordylanthus maritimus ssp. maritimus, is an endangered species that reaches its northern limit here.

Carpinteria Salt Marsh is one of several types of estuaries that are located in the Santa Barbara region. It is a regionally large wetland occurring in a structural basin and serves as a sediment trap for

streams that drain the Santa Ynez Mountains. The vegetation and flora of the site are characteristic of estuaries in southern California; however, each estuary is unique and usually isolated from other coastal wetlands. Carpinteria Salt Marsh like virtually all estuaries has a number of physical and biological attributes that contribute to its uniqueness. Some of these attributes include rare plant associations and species, a location near the northwestern limit of southern California, and the northern limit of at least one plant. Carpinteria Salt Marsh is also notable because of the extensive data base that is being compiled for its natural resources, and thus this estuary may serve in the future as a research site of national significance.

THE FUTURE



Photograph from the California Coastal Commission

PROPOSED ALTERATIONS
AND POTENTIAL IMPACTS

RECOMMENDATIONS

THE FUTURE

Major alterations to Carpinteria Salt Marsh have been projected during previous studies. Future land use alternatives included a large marina with associated resort and recreational facilities and residential areas that were predicted to cover the entire estuary by 1984 (California Division of Soil Conservation, 1967c). This extreme example of alteration of coastal wetlands has been implemented in other counties in southern California (e.g. Ventura, Los Angeles, Orange, and San Diego Counties) and might have been the fate of Carpinteria Salt Marsh if it were not for significant conservation legislation, such as the California Coastal Act (State of California, 1976), concern by area residents, and the stewardship of private land owners that resulted in the preservation of most of the wetlands.

However, throughout this book numerous impacts to sensitive coastal wetlands and uplands have been demonstrated, illustrating the many effects man has had on the native botanical resources of Carpinteria Salt Marsh and vicinity. The gradual process of urbanization, including the expansion of the City of Carpinteria and other residential and commercial areas, the development of agricultural and energy resources, and the subsequent need for flood control projects, have resulted in the filling and fragmentation of wetlands, channelization of streams, construction of ditches, dikes and levees, increase in runoff, accumulation of sediments and pollutants, erosion of the shoreline, and closure of the mouth of the estuary. Concerning the native botanical resources, these impacts have had both negative effects (e.g., loss of wetlands, change from one wetland type to another of less value, alteration of upland habitats, and reductions in the occurrence and abundance of some species and the extirpation of others) and positive effects (e.g. restoration of tidal circulation, and creation of new, more valuable wetland and upland habitats). An understanding of the results of past events provides insight into the potential effects of current and future projects associated with Carpinteria Salt Marsh, including, for example, those projects affecting watershed management and shoreline processes,

the preservation, restoration, and enhancement of wetlands, and the recovery of rare and endangered species.

PROPOSED ALTERATIONS AND POTENTIAL IMPACTS

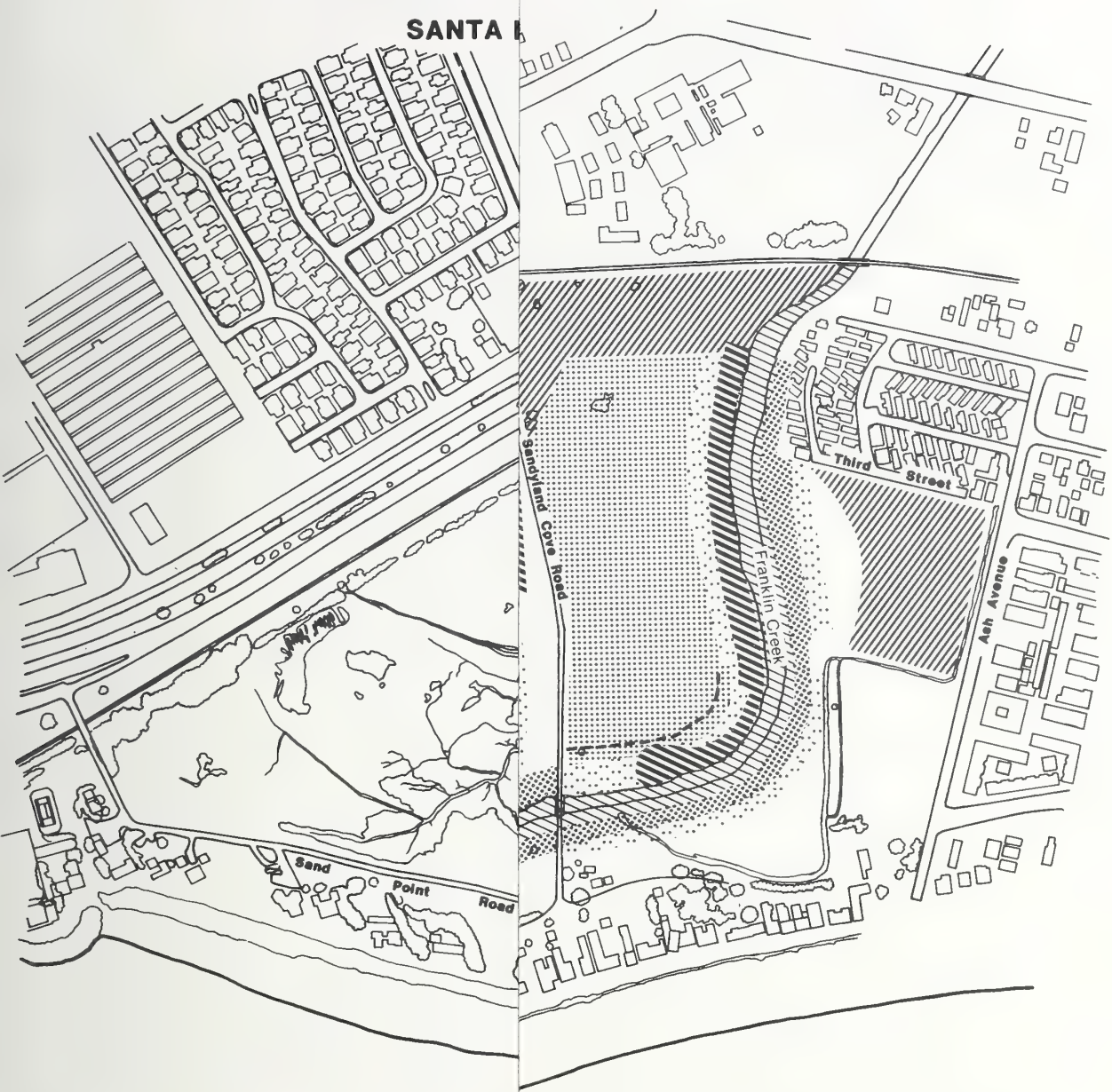
The future of Carpinteria Salt Marsh depends in part on several proposals that could affect the estuary significantly. These projects include some that mitigate the effects of past projects or impacts, some that pose direct threats to the estuary, and some that are probably only minor alterations to the estuarine system. Selected projects are discussed below and two are illustrated in Figure 35.

Carpinteria Valley Watershed Project - Significant flooding in portions of the Carpinteria Valley during the early 1960's, caused by major winter storms combined with factors such as fires in the upper watershed, sediment laden streams, development of the coastal plain, and lack of channels through the estuary to the ocean, produced enough regional concern that a watershed work plan was completed by 1968. Known as the Carpinteria Valley Watershed Project, this plan included many aspects of watershed and basin modifications to reduce the threats of erosion, flooding, and siltation that are especially acute during large storms with significant amounts of rainfall. The project was planned by the USDA Soil Conservation Service and local agencies including the Santa Barbara County Flood Control and Water Conservation District, Santa Barbara County Resource Conservation District, and the City of Carpinteria. The original work plan (Santa Barbara Soil Conservation District et al., 1967) included appendices on the hydrology, geology, and economy of the watershed and basin areas (California Division of Soil Conservation, 1967a,b,c). An addendum to the work plan (Santa Barbara Soil Conservation District et al., 1968), an Environmental Impact Statement (USDA Soil Conservation Service, 1976) and additional project information concerning the last phase of the project, the El Estero Improvement Project (USDA Soil Conservation Service, 1983; California State Coastal Conservancy, 1983), also have been completed

Fig. 35. EL ESTERO IMPR

CARPI

SANTA



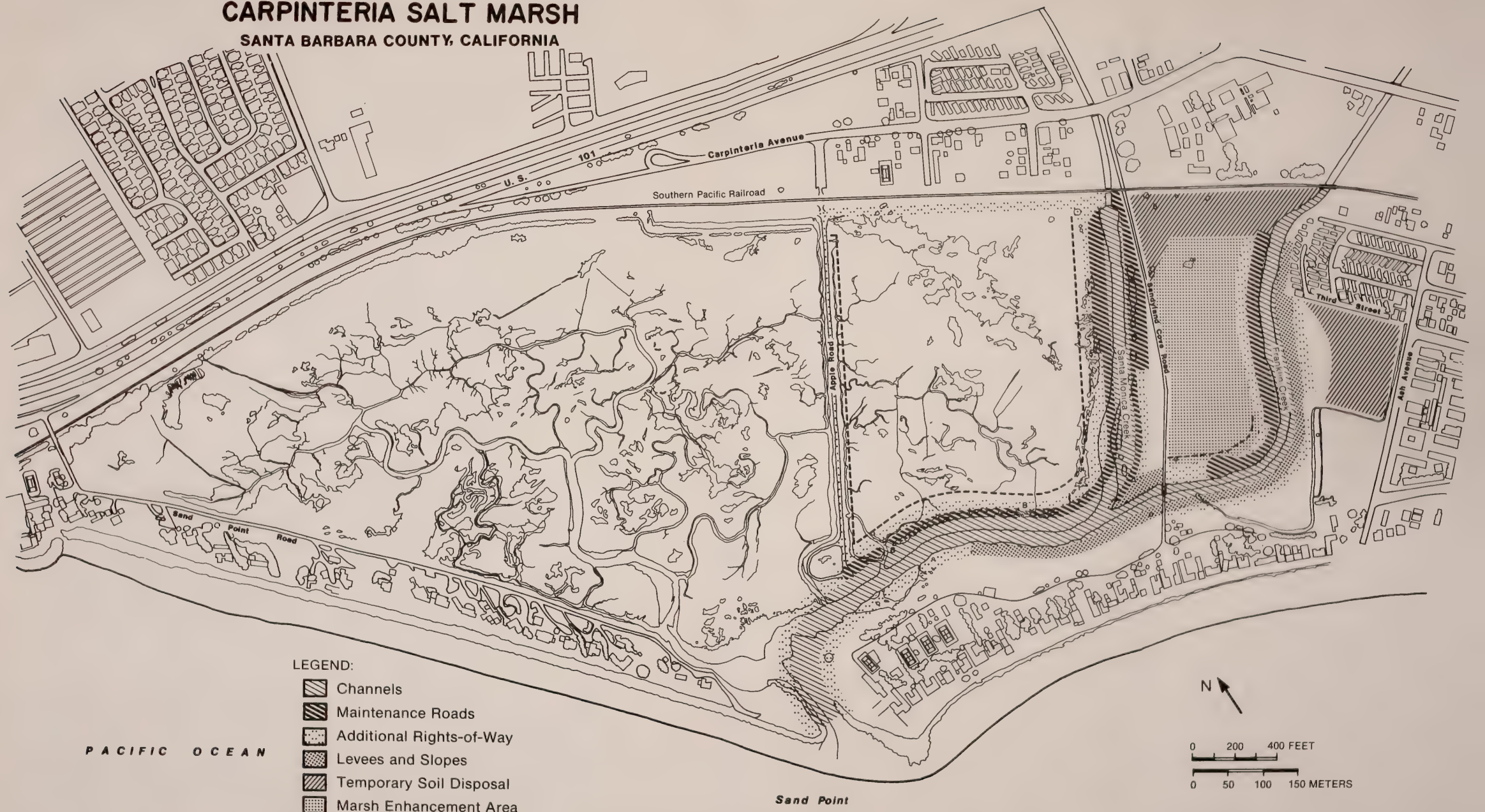
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Adapted from USDA Soil Conservation Service, 1983

Fig. 35. EL ESTERO IMPROVEMENT AND MARSH ENHANCEMENT PROJECTS



Adapted from USDA Soil Conservation Service, 1983

and together provide background data on the flood control proposals for Carpinteria Salt Marsh. Information for the following summary was obtained from these documents.

At least 24 damaging floods have occurred in the Carpinteria Valley over the last 105 years. Flood waters originating in this watershed during a single storm will inundate an average of 1250 acres once every 100 years. The 1914 flood was the worst in this century in the Carpinteria Valley and is considered a 100 year flood. During the 1914 storm, severe erosion occurred and resulted in the deposition of sediment in areas now in agricultural and urban development, and in the estuary where a large alluvial fan was deposited adjacent to Santa Monica Creek. The Carpinteria Valley Watershed Project was proposed to solve the erosion and flood problems by the application of land treatment and by structural measures. Land treatment included intensified fire protection in forest and chaparral vegetation, brush control, and improved ground cover, mulching, seeding, and irrigation management in agricultural lands. Also, channels and a debris dam were proposed for construction.

Thus far, all proposed portions of the project have been completed except those in Carpinteria Salt Marsh. The completed work includes 1) land treatment measures over 90% of the agricultural land; 2) about 14 miles of road improvement for access for fire control; 3) clearing of about 6.6 miles of new fuel breaks; 4) 5.7 miles of rectangular, concrete-lined channel on Franklin and Santa Monica Creeks; and 5) a compacted, earth fill dam to provide about 120 acre-feet of debris storage on Santa Monica Creek.

The remaining aspects of the Carpinteria Valley Watershed Project are included in the Carpinteria Estero Enhancement Plan (California State Coastal Conservancy, 1983), a portion of which is known as the El Estero Improvement Project (USDA Soil Conservation Service, 1983), and consist of improved outlet channels that will extend through the estuary to the ocean (Fig. 35). These channels will provide adequate flow capacities for Franklin and Santa Monica Creeks. Alterations to the

estuary include additional dredging of the creeks and construction of levees to direct flood flows away from homes and onto the salt marsh. Maintenance dredging from access roads on levees also is proposed. A discussion and contrast of the proposals contained in the Watershed Work Plan and the EIS has been prepared (USDA Soil Conservation Service, 1983). In this document, it is stated that changes in the Work Plan and the EIS occurred as a result of comments made at numerous meetings attended by various agency representatives, and as a result of the need to perform dredging to maintain channel capacities and to maintain an adequate tidal prism that would prevent sandbar formation at the mouth of the estuary.

Currently, the maintenance dredging of channels is conducted by dragline dredging. In an original improvement proposal, spoil was to be stockpiled within 50-foot wide maintenance areas along portions of the creeks and dried for a period of time after which the spoil would be hauled away. Because more extensive dredging is anticipated after large storms, or after storms following watershed fires, and in areas below the 50-feet wide work areas, spoil would have to be deposited temporarily along side 20-feet wide roads within designated rights-of-way. A hydraulic dredge has been suggested as an alternative method instead of dragline dredging, thus avoiding the need to dry dredge spoil. However, hydraulic dredges are not available locally on short notice when one might be needed immediately after a large storm.

Because existing permits obtained by the Santa Barbara County Flood Control and Water Conservation District prohibit the deposition of spoil below the elevation of 5 feet MSL, the above dragline proposal would require additional permits. The disturbance of estuarine wetlands that would occur during placement of spoil in the intertidal zone caused concern among agency representatives and resulted in the relocation of spoil management areas to locations south of the Southern Pacific Railroad along the upper portions of Franklin and Santa Monica Creeks. Rare high marsh habitats in some of these areas are potentially threatened by placement of spoil adjacent to Santa Monica Creek, because portions of the vegetation occur above the elevation of 5 feet. This vegetation is

not present, however, in the proposed temporary spoil storage sites (Figs. 13, 14, 35).

In the currently proposed El Estero Improvement Project (USDA Soil Conservation Service, 1983), construction activities would temporarily disturb about 45 acres of Carpinteria Salt Marsh. In the construction of permanent project features, including channels, levees, and maintenance roads, about 86,000 cubic yards of material will be excavated; 17,500 cubic yards of which will be used for fill in the marsh to create levees and access roads, and 68,500 cubic yards of which will be removed from the area. Constructive easements and rights-of-way will be acquired to provide access and dredge spoil drainage areas. Temporary spoil storage areas will be used only during construction. Once the spoil has drained it will be removed and the areas will be returned to existing elevations and replanted with upland vegetation.

Other construction activities affecting biological resources include the dewatering, by use of temporary dams, and the dredging of existing open water areas of Franklin and Santa Monica Creeks. During this process some estuarine wetlands will be deprived of tidal flushing, but the majority of salt marsh habitats will be unaffected. The plants in areas deprived of tidal circulation will be stressed but should survive since the soils are expected to remain moist. Other disturbances to botanical resources include the following: 1) removal of most upland vegetation in maintenance areas to be used by vehicles during construction; 2) disturbance of salt marsh vegetation along creeks and the covering of other areas during construction of new levees or access roads; 3) disturbance of a 50-feet wide strip along portions of some channels during operation of equipment or temporary storage of spoil; 4) annual maintenance dredging along the upper 850 feet along Franklin Creek and continual disturbance of storage areas; 5) maintenance dredging along the upper 850 feet of Santa Monica Creek once a decade and occasional disturbance of storage areas; and 6) maintenance dredging along the confluence of the creeks once every 15 years and temporary disturbance of about 1 1/4 acres of habitat for temporary storage.

Expected changes in the estuary and surrounding area include the following: 1) an increase of open water by 4.0 acres; 2) an increase of intertidal flats by 0.3 acres; 3) a reduction of upland by 2.9 acres; 4) a reduction of salt marsh by 0.3 acres; a reduction of sandspit and urbanized areas by 0.7 acres; and 5) a widening and deepening of channels that will increase the tidal prism. The 0.3 acre net reduction in Estuarine Emergent Wetland represents a loss of less than 0.5% of the total salt marsh habitat as mapped by others (USDA Soil Conservation Service, 1983). The increase in tidal prism is expected to reduce the possibility of sandbar development and closure of the mouth of the estuary, providing an enhancement to the environmental quality of the tidal habitats.

Revegetation of disturbed areas is proposed. Temporary rights-of-way, easements, and dredge spoil storage areas will be returned to preproject elevations following construction. All disturbed areas will be revegetated except open water areas, intertidal flats, and those sites that will receive disturbance during various intervals.

Several additional changes to the estuary are proposed as part of the enhancement aspect of the project. For example, new culverts on the south side of Franklin Creek will permit increased tidal circulation in about 4 acres of salt marsh east and south of Franklin Creek. An enlarged opening on the north side of Franklin Creek may increase tidal circulation between Franklin Creek and Sandyland Cove Road (Basin 1). Two new openings and the enlargement of an existing opening on the north side of the confluence of the creeks will increase tidal circulation in the area between Santa Monica Creek and Apple Road (Basin 2). Furthermore, an enlarged channel on the east side of Apple Road will provide additional circulation in Basin 2.

Implementation of the proposed El Estero Improvement Project will complete the Carpinteria Valley Watershed Project. The entire project is expected to not only protect the area from most floods, but to also provide a wetland maintenance program to minimize future rapid growth of alluvial fans and thus minimize sediment accumulation in the estuary.

Increased tidal circulation in much of the salt marsh and a reduced potential for mouth closure will provide an overall enhancement of habitat values at Carpinteria Salt Marsh. Evidence of vegetation change as presented herein demonstrates clearly the importance of having an open mouth for this type of estuary. Some estuaries in California that are not dominated by Salicornia virginica, but by species characteristic of conditions that are less saline as in lagoons, do not require regular tidal flushing and thus infrequent or seasonal opening of their mouths is adequate.

Marsh Enhancement Project - Associated with the El Estero Improvement Project is a plan to enhance the habitats occurring between Franklin Creek and Sandyland Cove Road (Basin 1). The California State Coastal Conservancy, in conjunction with the Santa Barbara County Flood Control and Water Conservation District, would fund the enhancement work when an entity, such as the UC NRS, is identified that will manage the project on a long-term basis (Riddle, 1985). The project design (USDA Soil Conservation Service, 1984; California State Coastal Conservancy, 1983) includes the dredging of tidal channels around central areas to create islands supporting undisturbed high marsh vegetation that would provide habitat for the Light-Footed Clapper Rail. The channels are proposed to create a barrier to predators of the Rail, and the slopes of the channels would provide graduated salt marsh habitat (Riddle, 1985).

This project would return tidal circulation to an area that was altered as a result of alluvial fan deposition and the construction of berms. The basin is characterized currently by palustrine wetland, upland, and dredge spoil. The enhancement project is expected to improve the environmental quality of the site and is designed in parts to mitigate aspects of the El Estero Improvement Project. The topographic relief proposed for the site would provide habitat diversity important to the survival of the Light-Footed Clapper Rail and the natural diversity of botanical resources at Carpinteria Salt Marsh.

The El Estero Improvement and Enhancement Projects (Fig. 35) together provide several features of particular note (California State

Coastal Conservancy, 1983). These include the following: 1) dredging of tidal channels to improve tidal flushing; 2) restoration of about 15 acres of upland and degraded wetland to wetland habitat; 3) recontouring of existing levees to encourage the growth of important plant species and to ensure future floods do not deposit sediment in the salt marsh; 4) a restoration program for the Light-Footed Clapper Rail; 5) improvement of habitat values on about 36 acres of wetland in Basin 1; and 6) the reduction of flooding potential of residential areas adjacent to Carpinteria Salt Marsh.

Proposed Public Recreation Pier - In the Coastal Plan for the City of Carpinteria (City of Carpinteria, 1980), Policy 7-4 was adopted, stating that a feasibility study should be conducted concerning the development of a recreational pier, boat launching facility, and other support facilities at the Carpinteria Beach. Such a study was required to determine the optimal location for the pier, the potential impacts of the development on Carpinteria Salt Marsh, and other points. A Draft Environmental Impact Report (Michael Brandman Associates, 1985) was completed, assessing the impacts of constructing a recreational pier at the south end of Ash Avenue, in addition to two other sites. The Ash Avenue alternative would require construction of a parking lot on property immediately adjacent to and including estuarine wetlands on the eastern margin of Carpinteria Salt Marsh. Filling of much of the estuarine wetlands within the City Limit was predicted. Although not evaluated adequately in the Draft EIR, significant impacts of the Ash Avenue alternative include loss of estuarine wetland and loss of the potential to restore adjacent upland areas to wetland habitats. This same property along Ash Avenue was proposed several years ago as a site for a wetland restoration project sponsored by the California State Coastal Conservancy, but that proposal is no longer under consideration.

Greenhouse Development - The effects of greenhouse development on Carpinteria Salt Marsh have been discussed in a previous section of this book (see: BOTANICAL RESOURCES--Disturbance and Vegetation Change). Briefly, researchers have found that nutrients, sediments, and toxic

chemicals have entered the western portion of the estuary through several drainages located between Apple and Sand Point Roads. This problem has been attributed (Page, 1979; Stanley and Scholin, 1984; County of Santa Barbara, 1985) to agricultural development, including greenhouses, that occurs along the northern margin of Carpinteria Salt Marsh, north of US Highway 101. A summary of the effects of greenhouse development on the Carpinteria Valley has been compiled recently (County of Santa Barbara, 1985). In this report, it was stated that, "Of all the issues involving greenhouse development, potential impact on the Carpinteria Marsh is considered to be among the most important. However, the Marsh issue is difficult to deal with because of the many inter-relating variables pertinent to, and affecting this unique ecosystem."

A Technical Review Team has been appointed by the County of Santa Barbara to review the Discussion Draft of the greenhouse development report. Tentative findings of this Draft include the following: 1) the existing mitigation measures (e.g., use of retention basins to promote groundwater recharge and control runoff from buildings) appear to be effective, but use of these needs to be standardized; 2) a consistent analysis of the cumulative impacts of new greenhouse development on areawide and subarea bases needs to be added to the review and planning process; 3) a water quality monitoring program involving monitoring of point-source water flows from individual greenhouses as well as groundwater basins and Carpinteria Salt Marsh needs to be implemented; 4) additional hydrological studies need to be done to assist with the understanding of the interrelationship between groundwater flows from perched and recharge areas and the Carpinteria Marsh; 5) a better understanding of the effects of nitrates, specific pesticides, and other chemicals on water quality and marsh species must be achieved to develop the most effective conditions and design criteria for individual greenhouse projects and general development in the vicinity of Carpinteria Salt Marsh; and 6) a better understanding of how open field agriculture affects surface and groundwater quality is necessary to assess water quality and related impacts on the estuary.

The Discussion Draft is an important step in the process of resolving water quality issues at Carpinteria Salt Marsh. The biological resources supported by the estuary will be influenced positively by the implementation of improved mitigation measures and by recommendations of the Technical Review Team. Authors of the Draft recognize the importance of the greenhouse issue in a concluding paragraph: "It may be that...more control over irrigation run-off and the mobility of fertilizers and pesticides can be accomplished through conversion of open field agriculture to greenhouses. If this is true, then such increased control could actually reduce the levels of nutrient and chemical pollutants entering the marshlands. Nevertheless, recent problems of contamination of the marsh by effluents and waste waters from the Sandyland Nursery constitute an important example of how increased impervious surfaces in conjunction with uncontrolled disposal of waste water from a greenhouse operation can acutely impact wetland habitats."

One conclusion of the draft report is that County policy and mitigation measures will contribute to a reduction in greenhouse effluent containing contaminants. Improved conditions are essential to prevent further degradation of the western basin of the estuary. The Coastal Act (State of California, 1976) and the Coastal Plan (County of Santa Barbara, 1980) require that new development adjacent or in proximity to wetlands shall be compatible with these environmentally sensitive areas, and shall not result in a reduction of biological productivity or degradation of water quality due to runoff or other disturbances (County of Santa Barbara, 1985). Thus, future greenhouse development in the Carpinteria Valley must meet policy requirements concerning the environmental quality of Carpinteria Salt Marsh.

Water Diversion Projects - With the scarcity of groundwater resources being an important factor in the growth rate of the South Coast of Santa Barbara County, it is not surprising that techniques have been developed or proposed for the utilization of runoff from regional watersheds. Two examples for the South Coast include one that will affect the amount of freshwater entering Goleta Slough from Glen Annie and McCoy Creeks (Envicom, 1983), and one that will affect the amount of freshwater entering Carpinteria Salt Marsh from Santa Monica Creek

(Penfield Smith, 1982; Woodward-Clyde, 1982). Water diverted from streams during winter flows is proposed for storage in reservoirs or for injection into groundwater basins.

The Carpinteria County Water District plans to appropriate surface water from Santa Monica Creek for use in a groundwater recharge program. This project is sponsored by the Chevron Land and Development Company to provide a supplemental water supply to the District to mitigate adverse environmental impacts from a residential development project (Carpinteria Bluffs Area I Specific Plan) submitted to the City of Carpinteria by the sponsor. About 150 acre feet per year (AFY) or 12% of surface water surplus flow are proposed for removal from Santa Monica Creek and thus from the freshwater flowing into Carpinteria Salt Marsh. Impacts to habitats along Santa Monica Creek and to the biological resources of the estuary are of special concern.

An environmental assessment of the Santa Monica project prepared by Keith B. Macdonald (Woodward-Clyde, 1982) provides an analysis of the potential impacts of the proposed water diversion. For example, prior to modifications of Santa Monica Creek that were constructed as part of the Carpinteria Valley Watershed Project in 1974, the average annual discharge from Santa Monica Creek was estimated to be 600 AFY. Following modifications such as channelization and lining with cement, a minimum of 60 AFY and as many as 100 AFY of runoff that once recharged the groundwater basin now flows out to the Pacific Ocean. Because the proposed project design will ensure that the greatest quantities of water are diverted during the peak stream flows [the flows range approximately from 58 to 6300 cubic feet per second (CFS)], only moderate reduction in the annual flow conditions in Santa Monica Creek are predicted (Woodward-Clyde, 1982).

Effects of the project on stream and salt marsh ecosystems are expected to be minimal. Because Santa Monica Creek is cement-lined from above the project downstream to the estuary, the project is predicted to have no impact on the ecology of Santa Monica Creek upstream from Carpinteria Salt Marsh. Likewise, Macdonald states that, "The absence

of apparent freshwater influence along Santa Monica and Franklin Creeks, seaward of the Southern Pacific Railroad, suggests that an average annual reduction in total freshwater input [to the estuary] from 1,230 acre-feet to 1,080 acre-feet will have no significant impact on either the specific biota or general health and ecology of the Carpinteria Marsh complex." He also concludes that the proposed stream division will have minimal effect on sediment transport in Santa Monica Creek and no significant impact on the breaching of ocean inlet sandbars by storm runoff. Thus, there should be no increased deposition of sediment in the estuary and tidal flushing of the estuary should not be effected, because reduced capacity for storm runoff to keep the outlet open is not expected to occur.

Of great importance, however, is one of the long-term impacts listed in the Woodward-Clyde report: "Should additional water diversion and injection programs similar to that considered here be proposed for Santa Monica or Franklin Creeks, their cumulative impacts are likely to become increasingly adverse as stream flows are further diminished. In this regard, approval of this particular facility could reduce the flexibility of future water resource allocations and regional planning activities. The situation is not irreversible, however, as operation of the proposed facility could be discontinued at some time in the future if such a decision were appropriate." Macdonald concludes that the water diversion and injection facility proposed for Santa Monica Creek will have no significant long-term adverse environmental impacts.

Oil Development - Twenty oil or gas fields occur in the northern Santa Barbara Channel and produce from sandstones that underlie relatively impermeable mudstones (Jackson and Yeats, 1982). The Summerland Offshore oil field, discovered in 1957, is the easternmost of these and produces, off the coast of Summerland and the Carpinteria Valley, from a gently-folded anticline into which the oil migrated during middle to late Pleistocene time (Jackson and Yeats, 1982). Oil was obtained previously from adjacent fields, including the abandoned Summerland oil field, that was discovered in 1896 and became the first offshore oil field in the United States (Arnold, 1907).

A large oil spill on January 28, 1969, from Platform A, an offshore drilling platform located on a federal oil lease off the coast of Summerland and southwest of the Carpinteria Valley, caused extensive damage to the intertidal and nearshore flora and fauna of a portion of the Santa Barbara coast (Holmes and DeWitt, 1970; Macdonald, 1976). Ecological effects of the spill, however, were not as dramatic as had been predicted shortly after the accident (Straughan, 1970). At least one account of the spill (Macdonald, 1976) reports that it did not cause major contamination of Carpinteria Salt Marsh, because floating crude oil was prevented from entering the estuary due to a sand berm that was constructed hastily at the mouth. Mr. William Traverse, a resident at Sandyland during the incident, reports (personal communication, 1985), however, that the berm was not constructed until a week after the spill occurred and that more than one half of the salt marsh was impacted by oil. He states that oil was 4 to 5 inches thick in channels near the mouth and thinned towards the margins of the estuary. He observed that during the year following the spill, the crude oil was apparently decomposed by bacteria. Thus, the oil spill had at least a short-term significant impact at Carpinteria Salt Marsh and perhaps unknown long-term effects to organisms in the wetlands.

The California Coastal Act (State of California, 1976) and the Santa Barbara County Coastal Plan (County of Santa Barbara, 1982) address development of petroleum resources and the potential impacts of such development in State Tidelands and onshore areas of the Coastal Zone. Because various aspects of the oil industry are forms of development permissible in regions protected by the Coastal Act, environmental reports analyzing proposed oil developments must address policies adopted by the State that control the construction and operation of facilities in the Coastal Zone. Federal jurisdiction occurs in offshore areas beyond State Tidelands.

A number of environmental impact reports required by the California Environmental Quality Act (CEQA) and environmental impact statements required by the National Environmental Protection Act (NEPA) have been prepared recently for proposed oil production off the coast of Santa

Barbara County. These reports or technical appendices include, for example, Mulroy et al. (1984), Howald et al. (1985), State Lands Commission and County of Santa Barbara (1985), and Continental Shelf Associates, Inc. (1985). Concern for coastal resources such as estuaries (including those at the mouths of the Santa Monica and Santa Ynez Rivers and at Devereux Slough, Goleta Slough, Carpinteria Salt Marsh, and others) is expressed in these reports through analysis of potential impacts and cumulative effects, and by proposals of mitigation measures.

As discussed in the reports cited above, impacts to estuaries from the development of petroleum resources can occur through various accidents and catastrophic events, including but not restricted to the following: 1) crude oil spills caused by ruptive and terrestrial pipelines at stream crossings during seismic activity or landslides, resulting in the movement of oil downstream and into estuarine wetlands; 2) crude oil spills at processing facilities located near estuaries or streams; 3) crude oil spills from platforms or subsea pipelines, resulting in a floating mass of oil that could be washed into estuaries; and 4) crude oil spills from offshore tanker accidents. Other forms of pollution (e.g., spills of diesel oil and discharge of man-made wastes over long periods of time) that affect intertidal and subtidal organisms have been discussed by Neushul (1970).

Impacts to the marine, estuarine, and dune biota from crude oil spills are estimated (e.g., Howald et al., 1985) to be locally to regionally significant depending on the amount of oil deposited and the extent of its distribution along the coast. Impacts could result from the following: 1) direct contact of organisms with oil; 2) soil, water, and substrate contamination; and 3) cleanup operations during which oil-covered materials are removed from the environment (Howald et al., 1985). Impacts include death or injury to organisms, for example, because of the following: 1) toxic soil conditions; 2) reduced availability of water to plants; and 3) direct contact of oil causing loss of foliage and reduced photosynthesis, nutrient levels, and flower and seed production (Hutchinson et al., 1974). Straughan (1970) reported that

following the Santa Barbara oil spill in January 1969, various intertidal marine organisms were killed apparently as a result of smothering by thick layers of oil, but that some populations of Phyllospadix (Surf Grass) and Hesperophycus harveyanus (an alga), also killed during the event, had begun recovering by August of the same year.

Of immediate importance to the environmental quality of Carpinteria Salt Marsh is a proposal by Chevron U.S.A., Inc. to locate an offshore oil platform in lease PRC 3150, about 0.5 miles (0.8 km) south of the mouth of the estuary (Continental Shelf Associates, Inc., 1985). Among the impacts to enviromental resources discussed in the Draft EIR (Continental Shelf Associates, Inc., 1985) are the potential impacts to "unique marine environments," including the habitats for endangered species in estuaries. Such resources at Goleta Slough, Carpinteria Salt Marsh, and other sites along the coast in the vicinity of this proposed platform could be seriously affected by an oil spill, as stated in the Draft EIR. "Prepositioning spill response equipment [e.g., booms and bulldozers] is most critical for [Carpinteria Salt Marsh] due to the relatively short time (45 minutes) needed for a spill originating at PRC 3150 to reach the Carpinteria nearshore area (Continental Shelf Associates, Inc., 1985). Recommendations such as the prepositioning of equipment are essential if Carpinteria Salt Marsh is to be spared impacts from other potential crude oil spills, particularly because of the proximity of the recently proposed platform to the mouth of the estuary.

Mosquito Abatement Proposals - Mosquitoes have been a problem at Carpinteria Salt Marsh (Macdonald, 1976), but regular tidal circulation within the estuary has eliminated serious infestations. However, spot sprays and rare major aerial spraying have been utilized by the Mosquito Abatement District when problems occur. Because of the accumulation of sediments and debris, and the disruption of circulation patterns by berms and levees, the ponding of water within basins, ditches, and channels can occur resulting in breeding areas for mosquitoes. Although this situation has been identified at both Goleta Slough and Carpinteria Salt Marsh, an application for work in estuarine wetlands has been made

only for the Goleta Valley to date. Activities proposed include those that are classified as enhancement, such as removal of vegetation that hangs over or grows in waterways and the removal of debris; and those that are classified as restoration, such as the hand-ditching of new channels. Both activities will improve tidal circulation within portions of the estuary and thereby reduce mosquito breeding. A map illustrating potential areas of enhancement or restoration within Carpinteria Salt Marsh has been prepared, but an application for implementation of the plan has not been filed (Stannard, personal communication, 1985). Because some of the problems of tidal circulation may be corrected by the El Estero Improvement and Enhancement Projects, proposals by the Mosquito Abatement District may be made only after completion of projects by the County Flood Control District. Marsh alterations proposed for control of mosquitoes would have only minor impacts on botanical resources such as some vegetation removal. However, the improved tidal circulation could provide important benefits to stagnant areas of both estuaries.

Salt Marsh Bird's-Beak Recovery Plan - An agency review draft of the "Recovery Plan for the Salt Marsh Bird's-Beak (Cordylanthus maritimus ssp. maritimus) was issued recently (U.S. Fish and Wildlife, 1983a), recommending various tasks considered necessary for the recovery and eventual delisting of this endangered plant (see: BOTANICAL RESOURCES--Endangered Species). In the executive summary of the Plan, the following points were emphasized: 1) the taxon could be considered non-endangered when colonies with population levels equalling or exceeding those established as baseline populations have been maintained in at least 12 major sites within the plant's historic range for 5 consecutive years; 2) full recovery and ultimate delisting of the Salt Marsh Bird's-Beak can only be achieved by restoring and maintaining the coastal salt marsh ecosystems upon which the plant depends; 3) protection and restoration of present and historical localities and reestablishment and protection of the plant in historical marshes must be done to meet recovery goals, and 4) protection of salt marshes where Salt Marsh Bird's-Beak occurs and protection of high marsh from development and

other human-caused factors in perpetuity is essential to sustain the recovery of the species.

Carpinteria Salt Marsh is one of the few estuaries where Cordylanthus maritimus ssp. maritimus still occurs. Because prime objectives of the recovery plan include the preservation of existing colonies and the management of sufficiently secure habitats to achieve and maintain populations necessary to eventually delist this endangered plant, Carpinteria Salt Marsh is considered a significant part of the plan. The estuary is important as the only Santa Barbara County locality for the taxon and as the present and historic northwestern limit of the plant as based on herbarium records and reliable sources. The Recovery Plan provides detailed steps relating to the status of Salt Marsh Bird's-Beak at Carpinteria Salt Marsh. Specifically, plans should be developed and implemented for management of the estuary to protect habitats of the taxon, and changes in distribution and abundance of the plant and its habitat should be monitored.

Having provided a recovery plan for this endangered species, the U.S. Fish and Wildlife Service (1985) has requested proposals for "Manipulative Management of the Salt Marsh Bird's-Beak in Southern California." Plants of C. maritimus ssp. maritimus at Carpinteria Salt Marsh will probably be used as a seed source to reintroduce this taxon into other estuaries in southern California. Thus, Carpinteria Salt Marsh is not only important as a current habitat for Salt Marsh Bird's-Beak, but also will be important in the implementation of the Recovery Plan, including the establishment of the plant in salt marshes not currently supporting it.

Light-Footed Clapper Rail Recovery Plan - An agency review draft of the Light-Footed Clapper Rail Recovery Plan (U.S. Fish and Wildlife Service, 1983b) has been circulated for comment and includes plans for Carpinteria Salt Marsh that could have profound effects on the botanical resources of the estuary. The Light-Footed Clapper Rail is an endangered bird that is restricted to salt and brackish marshes along the immediate coast and requires a healthy marsh environment with Spartina

foliosa (California Cordgrass) or Salicornia virginica (Pickleweed) for nesting and escape cover, abundant food (salt marsh invertebrates), tidal flats interspersed with salt marsh vegetation as feeding areas, and limited human disturbance (U.S. Fish and Wildlife Service, 1983b). Carpinteria Salt Marsh is the only current locality for this bird in Santa Barbara County, and about 13 pairs are permanent breeding residents here (Lehman, 1982). This estuary is important because it is the most northerly wetland in which this Clapper Rail presently occurs, it supports the fourth largest population of the bird in California, and is one of only a few locations where S. foliosa is not an important aspect of the habitats (Onuf, 1984a).

A series of management actions for Carpinteria Salt Marsh are contained in the Plan and include the following: 1) protective measures such as acquisition, conservation easements, and cooperative agreements; 2) tidal circulation enhancement to provide rail thoroughfares, cover, and foraging areas; 3) development of low marsh (Spartina foliosa and areas of Spartina--mudflat interface) because this is the preferred habitat of the rail; 4) resolution of water quality problems so that adverse effects of contaminated effluent on wetland vegetation, the invertebrate food source, and the rails can be minimized or prevented; and 5) control or reduction of sedimentation to prevent conversion of coastal wetlands to upland habitats, resulting in a reduction in numbers of rails.

While many of the management actions (e.g., enhancement of tidal circulation and control of contaminants and sedimentation) are consistent with the maintenance of this wetland for other resources, or for the health of the ecosystem as a whole, the proposal to develop low marsh dominated by Spartina foliosa is inconsistent with the general goals of enhancement and preservation of the estuarine wetlands. California Cordgrass has never been recorded from Carpinteria Salt Marsh, and thus introducing it to this estuary would alter the natural integrity of the ecosystem. Furthermore, environmental conditions at Carpinteria Salt Marsh do not include sufficient tidal inundation to support S. foliosa (see: BOTANICAL RESOURCES--Vegetation). The Light-

Footed Clapper Rail Recovery Plan includes many important steps in an effort to increase numbers of rail and eventually permit delisting of this bird from its endangered status. However, the Light-Footed Clapper Rail has persisted at Carpinteria Salt Marsh since at least the 19th Century (Lehman, 1982) without low marsh habitat dominated by S. foliosa. The modifications that could be employed in the attempt to establish S. foliosa might be detrimental to existing high quality habitat for rails without any assurance that the introduction of S. foliosa would be successful. Therefore the author feels this aspect of the Recovery Plan is not appropriate for Carpinteria Salt Marsh.

Summary - Future projects proposed for Carpinteria Salt Marsh and vicinity include beneficial alterations, such as the marsh improvement and enhancement plans, and negative impacts, such as proposals for a parking lot on the eastern margin of the salt marsh and the introduction of Spartina foliosa. Plans for improved water quality from greenhouse developments and recovery plans for endangered species also will affect the future of this estuary and should increase the significance of the site for biological resources. Potential catastrophic impacts from oil spills and unknown cumulative effects from water pollution and water diversion projects, however, must be considered potentially serious threats to the environmentally sensitive habitats of Carpinteria Salt Marsh.

RECOMMENDATIONS

Results of the botanical resource inventory and evaluation have permitted the author to consider actions that can be taken to protect, enhance, and appreciate the natural values of Carpinteria Salt Marsh. The following recommendations are organized in part according to the purposes stated in the introduction of this book.

Purpose 1. To conduct an inventory and evaluation of the botanical resources of a southern California estuary in the context of its physical environment and history.

Recommendations based on the results:

1. Recognition must be given to the special characteristics of Carpinteria Salt Marsh, including rare habitats, plant associations, and species, and the requirements for maintaining them, to insure proper management policies are developed for these resources.

2. Additional research should be conducted on the zoological resources and the ecological processes of the estuary to develop a data base, similar to that for the botanical resources, to be used to develop management policies.

3. An integrated management program for the entire wetland system should be developed to include all parcels of property.

4. Carpinteria Salt Marsh should be nominated for recognition at the national level as a site of biological significance. For example, one recommendation is to nominate the estuary for The Nature Conservancy list of aquatic sites in the contiguous United States that are in greatest need of conservation actions. This list is limited to sites significant for their

biological diversity (Fenwick, 1985), and criteria for inclusion on the list are as follow: 1) best intact remnants of damaged or declining ecosystems; 2) best opportunities for protection of representative, viable examples of major regional ecosystems; 3) sites of endangered species; 4) sites of endangered natural communities. Carpinteria Salt Marsh meets these criteria, further exemplifying the importance of this coastal wetland.

Purpose 2. To expand the environmental, historical, and botanical resource data base for Carpinteria Salt Marsh Reserve.

Recommendations based on the results:

1. Carpinteria Salt Marsh Reserve provides habitats for plant species and associations of regional and national significance that must be protected from degradation. Regionally rare plants (e.g., Lasthenia glabrata ssp. coulteri), a federally-listed endangered species (Cordylanthus maritimus ssp. maritimus), and regionally rare plant associations (e.g., alluvial fan high marsh wetland) all occur within the Reserve.

2. Ecological studies of the rare, annual, alluvial fan plant associations should be conducted to provide data that will assist with the management of this unique wetland. Access to this portion of the Reserve should be limited, and disturbance of the substrate and topography should be prevented.

3. Negotiations between the Natural Reserve System and the Sandyland Protective Association for acquisition or use agreements of land parcels west of the Reserve boundary should continue so that the high marsh association on sandbar deposits can be added to University property. This habitat supports the largest population of C. maritimus ssp. maritimus in the estuary and is the northern limit of this endangered plant.

4. Studies on ecosystem processes should be encouraged to provide the data required for responsible stewardship of the Reserve.

Purpose 3. To provide pre-project monitoring of botanical resources for the El Estero Improvement and Enhancement Projects.

Recommendations based on the results:

1. The El Estero Improvement Project should be initiated at the earliest possible date. Modifications proposed for the estuary as a result of these projects will be beneficial largely in terms of reduced frequency of closure because of increased tidal prism and better sediment management (Onuf, 1984a).

2. Sensitive wetland habitats on alluvial fan deposits in Basin 2, between Santa Monica Creek and Apple Road, must be protected during the project to prevent unintentional habitat destruction as a result of temporary dredge spoil storage and/or extension of work activities beyond proposed rights-of-way and easements.

3. The El Estero Enhancement Project should be implemented as proposed to restore tidal circulation to Basin 1, between Franklin Creek and Sandyland Cove Road, and to enhance wetland habitats for both botanical and zoological resources.

Recommendations based on other aspects of this study:

1. The Salt Marsh Bird's-Beak Recovery Plan and Manipulative Management Plan should be implemented. Only seeds from the Carpinteria Salt Marsh population, however, should be used within this estuary to establish new populations. The genotype of this northernmost population should not be introduced into more southern estuaries because extant populations within

or near these other wetlands should be used instead of those from the northern locality. Thus, regional differences in populations will be maintained.

2. The Light-Footed Clapper Rail Recovery Plan also should be implemented; however, proposals to establish Spartina foliosa for possible habitat improvement at Carpinteria Salt Marsh must be abandoned. Because conditions for growth of this plant are not adequate, alterations of the marsh to provide appropriate tidal elevation for it would be extensive. Furthermore, the biological integrity of the estuary would be altered because the species is not part of the natural flora.

3. The Salt Marsh Bird's-Beak and Light-Footed Clapper Rail Recovery Plans should be coordinated at Carpinteria Salt Marsh so that implementation of one plan will not interfere with the objectives of the other.

4. Effects on marsh productivity and organism diversity, including that of vascular plants, from polluted runoff entering the northern margin of marsh should be investigated further to determine the extent of impacts to the estuarine ecosystem. Improved quality of runoff water should be achieved with implementation of a greenhouse development plan.

5. Prepositioned oil spill response equipment at the mouth of the estuary should be required during the production phase of offshore platforms and associate facilities of the petroleum industry to prevent oil spills from entering Carpinteria Salt Marsh.

6. A comprehensive management plan for the entire estuary, as mentioned by Macdonald (1976), should be developed and should include input from all parties interested in the environmental quality of Carpinteria Salt Marsh. This plan should include an evaluation of all potential or real impacts and proposed mitigations as well as all plans for the ecosystem to avoid conflicts of interest that could cause a reduction of environmental quality.

SOURCES



Photograph by Stephen Stanley

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APPENDICES



Suaeda californica var. *pubescens*

CLASSIFICATION OF UPLAND VEGETATION

CLASSIFICATION OF WETLAND VEGETATION

ANNOTATED AND ILLUSTRATED
CATALOGUE OF VASCULAR PLANTS

A P P E N D I X I

CLASSIFICATION OF UPLAND VEGETATION

CARPINTERIA SALT MARSH
UPLAND VEGETATION

The upland vascular plant associations listed below are arranged in a hierarchical system modified from the habitat classification scheme of Cheatham and Haller (1975). Intraspecific taxa are excluded here but are listed in the Annotated and Illustrated Catalogue.

Because there has been long-term and widespread disturbance (e.g. diking, dredging, bulldozing, filling, ditching, etc.) in the uplands and adjacent wetlands it is difficult to apply a classification scheme to all the vegetation. Many intermediate or transitional forms of wetland vegetation result from the nature of disturbed substrates and unnatural topographic features. This classification attempts to account for such variability, including the high number of naturalized species. Not included here are plants extirpated from Carpinteria Salt Marsh and vicinity or those reported from habitats but not located by the author. The lists are not complete but were constructed to provide examples of characteristic species.

CLASSIFICATION OF UPLAND VEGETATION

MAJOR CATEGORY: Disturbed Coastal Habitat (Ruderal) Vegetation
HABITAT TYPE: Berms and Dredge Spoil
MAJOR SUBDIVISION: Leached and Saline Soil Types
MINOR SUBDIVISION: Early Successional Herbaceous Vegetation
CHARACTERISTIC SPECIES:

Anagallis arvensis
Atriplex patula
A. rosea
A. semibaccata
Avena fatua
Bassia hyssopifolia
Brassica geniculata
B. nigra
Bromus diandrus
Chenopodium berlandieri
C. murale
Conyza bonariensis
C. canadensis
Coronopus didymus
Cotula australis
C. coronopifolia
Heliotropium curassavicum
Hordeum murinum
H. geniculatum
Lavatera cretica
Lotus salsuginosus
Malva nicaeensis
M. parviflora
Medicago polymorpha
Mesembryanthemum nodiflorum
Polypogon monspeliensis
Raphanus sativus
Salicornia virginica
Salsola iberica
Senecio vulgaris
Sonchus oleraceus
Spergularia bocconii
S. marina

MINOR SUBDIVISION: Late Successional Herbaceous Vegetation
CHARACTERISTIC SPECIES:

Ambrosia psilostachya
Artemisia douglasiana
Aster subulatus
Atriplex semibaccata
Brassica geniculata
B. nigra
Bromus diandrus
B. hordeaceus
B. rubens
B. willdenovii
Carduus pycnocephalus
Carpobrotus edulis
Centaurea melitensis
Conium maculatum
Euthamia occidentalis
Foeniculum vulgare
Gnaphalium californicum
G. chilense
G. microcephalum
G. ramosissimum
Hemizonia fasciculata
Lolium multiflorum
Malacothrix saxatilis
Malephora crocea
Melilotus alba
M. indica
Oryzopsis miliacea
Raphanus sativus
Scrophularia californica
Verbena lasiostachys

HABITAT TYPE: Roadsides, Railroad Banks, etc.
MAJOR SUBDIVISION: Roadsides of Paved Roads
MINOR SUBDIVISION: Sandy Soils of Disturbed Dunes
CHARACTERISTIC SPECIES: (also refer to HABITAT TYPE: Dunes)

Ambrosia chamissonis
A. psilostachya
Bromus diandrus
Camissonia cheiranthefolia
Carpobrotus aequilaterus
C. edulis
Conyza bonariensis
C. canadensis

Cynodon dactylon
Distichlis spicata
Drosanthemum floribundum
Heliotropium curassavicum
Heterotheca grandifolia
Isocoma veneta
Lactuca serriola
Lupinus succulentus
Medicago polymorpha
Melilotus indica
Phacelia distans
Sonchus asper
S. oleraceus

MINOR SUBDIVISION: Deposits Adjacent to Paved Roads
CHARACTERISTIC SPECIES: (see HABITAT TYPE: Berms and Dredge Spoil)

Artemisia douglasiana
Atriplex patula
A. semibaccata
Avena fatua
Bassia hyssopifolia
Bromus diandrus
B. hordeaceus
B. rubens
B. willdenovii
Brassica geniculata
Calystegia macrostegia
Carpobrotus edulis
Conyza canadensis
Cynodon dactylon
Isocoma veneta
Lepidium virginicum
Nicotiana glauca
Pennisetum clandestinum
Rumex crispus
Solanum nigrum

MAJOR SUBDIVISION: Railroad Banks (largely nonvegetated)
CHARACTERISTIC SPECIES:

Chloris gayana
Convolvulus arvensis
Cynodon dactylon
Lavatera cretica
Pennisetum clandestinum
P. villosum
Polygonum aviculare
Ricinus communis
Salsola iberica
Sorghum bicolor

HABITAT TYPE: Debris Piles and Vegetation Persisting After Cultivation
CHARACTERISTIC SPECIES:

Amaryllis belladonna
Artemisia californica
Arundo donax
Baccharis pilularis
Brassica geniculata
B. nigra
Bromus diandrus
Carduus pycnocephalus
Carpobrotus edulis
Ceanothus megacarpus
C. spinosus
Centaurea melitensis
Conium maculatum
Cynodon dactylon
Elymus condensatus
Erodium cicutarium
Euthemia occidentalis
Foeniculum vulgare
Isocoma veneta
Malacothamnus fasciculatus
Medicago polymorpha
Melilotus alba
M. indica
Myoporum laetum
Opuntia basilaris
Pelargonium sp.
Pennisetum clandestinum
Phacelia ramosissima
Ribes amarum
Ricinus communis
Tropaeolum majus
Vinca major
Yucca sp.

MAJOR CATEGORY: Dune Habitats
HABITAT TYPE: Partially Stabilized and Stabilized Dunes

MAJOR SUBDIVISION: Coastal Foredunes
MINOR SUBDIVISION: Southern Coastal Foredunes
CHARACTERISTIC SPECIES: (see HABITAT TYPE: Roadsides)

Abronia umbellata	Carpobrotus aequilaterus
Ambrosia chamissonis	C. edulis
Cakile maritima	Distichlis spicata
Camissonia cheiranthifolia	Heliotropium curassavicum
	Tetragonia tetragonioides

MAJOR CATEGORY: Grassland
HABITAT TYPE: Valley Grassland
MAJOR SUBDIVISION: Cismontane Introduced Grasses
MINOR SUBDIVISION: Alluvial Fan Deposits (nonwetland)
CHARACTERISTIC SPECIES:

Avena fatua	Elymus condensatus
Brassica nigra	Euthamia occidentalis
Bromus diandrus	Heliotropium curassavicum
B. hordeaceus	Lolium multiflorum
Conium maculatum	Raphanus sativus
Conyza canadensis	

MAJOR CATEGORY: Scrub
HABITAT TYPE: Coastal Scrub
MAJOR SUBDIVISION: Coastal Sage Scrub (Coastal Berm Scrub)
MINOR SUBDIVISION: Alluvial Fan and Berm Deposits (also see MAJOR CATEGORY: Disturbed Coastal Habitat)
CHARACTERISTIC SPECIES:

Artemisia californica	Malacothrix saxatilis
A. douglasiana	Myoporum laetum
Atriplex lentiformis	Nicotiana glauca
A. semibaccata	Phacelia ramosissima
Baccharis glutinosa	Ricinus communis
B. pilularis	Sambucus mexicanus
Calystegia macrostegia	Scrophularia californica
Ceanothus megacarpus	Solanum douglasii
Elymus condensatus	S. xantii
Isocoma veneta	Stachys bullata
Malacothamnus fasciculatus	Suaeda californica

A P P E N D I X II

CLASSIFICATION OF WETLAND VEGETATION

CARPINTERIA SALT MARSH
WETLAND VEGETATION

The wetland vascular plant associations listed below are arranged in a hierarchical system modified from the wetland classification scheme of Cowardin et al. (1979). Infraspecific taxa are excluded below but are listed in the Annotated and Illustrated Catalogue. The vegetated wetlands can be grouped into two systems, as follow: 1) the Estuarine System, including subtidal and intertidal wetlands usually confined to coastal embayments or other physiographic features that are at some point during the year open to the ocean, receive freshwater runoff, and are flooded by water with an average annual low flow salinity (halinity) greater than 0.5°/oo from ocean-derived salts; and 2) the Palustrine System, including wetlands that are characterized by persistent plant types when vegetated (or if nonpersistent vegetation occurs the habitat is not a riverbed or streambed), and that are flooded by water with an average annual salinity less than 0.5°/oo from ocean-derived salts. A third system, Riverine, occurs upstream beyond the limits of the study area in highly-altered habitats such as riverbeds or streambeds that are characterized by nonpersistent plant types when vegetated and are flooded by water with an average annual low flow salinity less than 0.5°/oo from ocean-derived salts. A good example of riverine and nontidal palustrine wetlands occurs along Carpinteria Creek above the small estuary situated at its mouth. Similarly, the Marine System occurs beyond limits of the study area outside the mouth of the estuary and includes subtidal and intertidal habitats overlying the continental shelf and its coastline where salinities usually exceed 30°/oo.

Because there has been long-term and widespread disturbance in the wetlands and adjacent uplands (e.g. diking, dredging, scraping, filling, ditching, etc.) it is difficult to apply a classification scheme to all the vegetation. Many intermediate or transitional forms of wetland vegetation result from the nature of disturbed substrates and unnatural topographic features. This classification attempts to account for this variability. Not included here are plants extirpated from Carpinteria Salt Marsh and vicinity or those reported from habitats but not located by the author. The lists are not necessarily complete but were constructed to provide examples of characteristic species.

CLASSIFICATION OF WETLAND VEGETATION

SYSTEM: Estuarine
SUBSYSTEM: Intertidal
CLASS: Emergent Wetland
SUBCLASS: Persistent

WATER REGIME: Irregularly Exposed
CHARACTERISTIC SPECIES: (poorly drained ditches usually with freshwater influence)

Scirpus maritimus	Typha domingensis

WATER REGIME: Regularly Flooded (low salt marsh)
CHARACTERISTIC SPECIES:
Salicornia virginica

WATER REGIME: Irregularly Flooded I (Middle Marsh)
CHARACTERISTIC SPECIES: brackish affinities

Apium graveolens	Polypogon monspeliensis
Atriplex patula	Salicornia virginica
Cuscuta salina	Scirpus californicus
Distichlis spicata	S. maritimus
Jaumea carnosa	Typha domingensis

WATER REGIME: Irregularly Flooded II (Middle Marsh)
CHARACTERISTIC SPECIES: salt marsh

Arthrocnemum subterminale	Jaumea carnosa
Atriplex patula	Limonium californicum
Cuscuta salina	Salicornia virginica
Distichlis spicata	Triglochin concinna
Frankenia grandifolia	

WATER REGIME: Irregularly Flooded III (High Marsh)
CHARACTERISTIC SPECIES I: lower margin of alluvial fan salt flats

Arthrocnemum subterminale

CHARACTERISTIC SPECIES II: alluvial fan deposits, upper margin of salt flats

Arthrocnemum subterminale	Lolium perenne
Hordeum depressum	Monanthochloe littoralis
Hymenolobus procumbens	Parapholis incurva
Juncus bufonius	Salicornia virginica
Lasthenia glabrata	Spergularia marina
Limonium californicum	Suaeda calceoliformis

CHARACTERISTIC SPECIES III: Sandbar deposits in estuary

Arthrocnemum subterminale	Cakile maritima
Atriplex californica	Cordylanthus maritimus
A. patula	Cuscuta salina
A. watsonii	Distichlis spicata

Frankenia grandifolia	Limonium californicum
Isocoma veneta	Monanthochloe littoralis
Jaumea carnosa	Salicornia virginica
Lasthenia glabrata	Spergularia macrotheca

CHARACTERISTIC SPECIES IV: Upper banks and tops of low berms

Arthrocnemum subterminale	Frankenia grandifolia
Atriplex californica	Heliotropium curassavicum
A. lentiformis	Isocoma veneta
A. patula	Jaumea carnosa
A. semibaccata	Monanthochloe littoralis
A. watsonii	Parapholis incurva
Bassia hyssopifolia	Salicornia virginica
Beta vulgaris	Silene gallica
Bromus diandrus	Sonchus oleraceus
Carpobrotus edulis	Spergularia macrotheca
Cordylanthus maritimus	S. marina
Cotula coronopifolia	Suaeda californica
Cuscuta salina	S. calceoliformis
Distichlis spicata	

CHARACTERISTIC SPECIES V: Upper "brackish marsh" (Transitional to Palustrine Emergent Wetland)

Anemopsis californicus	Frankenia grandifolia
Apium graveolens	Picris echioides
Baccharis douglasii	Salicornia virginica
Carpobrotus edulis	Scirpus californicus
Equisetum telmateia	Typha latifolia
Euthamia occidentalis	

WATER REGIME: Irregularly Flooded IV - Transitional Vegetation

CHARACTERISTIC SPECIES I: Transitional Wetland/Grassland Vegetation on alluvial fan deposits

Ambrosia psilostachya	Euthamia occidentalis
Arthrocnemum subterminale	Frankenia grandifolia
Avena fatua	Galium aparine
Brassica nigra	Heliotropium curassavicum
Bromus diandrus	Lolium multiflorum
B. hordeaceus	Medicago polymorpha
Conium maculatum	Raphanus sativa
Conyza canadensis	Rumex crispus
Eucrypta chrysanthemifolia	Salicornia virginica

CHARACTERISTIC SPECIES II: Transitional Wetland/Ruderal Vegetation on berms of intermediate elevation

Ambrosia psilostachya	Artemisia californica
Arthrocnemum subterminale	Aster subulatus

Atriplex lentiformis	Heliotropium curassavicum
A. patula	Heterotheca grandiflora
*A. semibaccata	Hordeum geniculatum
Avena fatua	H. murinum
Bassia hyssopifolia	Limonium californicum
Beta vulgaris	Malephora crocea
Bromus diandrus	Melitotus indica
B. hordeaceus	Mesembryanthemum nodiflorum
B. rubens	Raphanus sativis
Carpobrotus edulis	Rumex crispus
Conyza canadensis	Salicornia virginica
Cuscuta salina	Salsola iberica
Distichlis spicata	Sonchus oleraceus
Frankenia californica	Tetragonia tetragonioides

*frequently dominant

CLASS: Scrub/Shrub Wetland
SUBCLASSES: Broadleaved and Succulent, Deciduous and Evergreen
WATER REGIME: Irregularly Flooded
CHARACTERISTIC SPECIES I: banks or tops of berms

Atriplex lentiformis	Suaeda californica

CHARACTERISTIC SPECIES II: alluvial fan, sandbar and berm deposits

Baccharis pilularis	Isocoma veneta
	Myoporum laetum

SYSTEM: Palustrine
CLASS: Aquatic Bed
SUBCLASS: Rooted Vascular
WATER REGIME: Seasonally Flooded
CHARACTERISTIC SPECIES: saline vernal depressions
Ruppia maritima

SUBCLASS: Floating
WATER REGIMES: Seasonally or Permanently Flooded
CHARACTERISTIC SPECIES: freshwater ditches
Lemna minor

CLASS: Emergent Wetland I - Freshwater Affinities
SUBCLASS: Persistent
WATER REGIME: Seasonally or Permanently Flooded, Saturated
CHARACTERISTIC SPECIES I: ditches, seeps

Agrostis stolonifera	Euthamia occidentalis
Apium graveolens	Equisetum telmateia
Aster subulatus	Juncus textilis
Atriplex patula	Nasturtium officinale
Baccharis douglasii	Polygonum punctatum
Cyperus eragrostis	Scirpus maritimus
Echinochloa crusgalli	S. microcarpus

Typha domingensis
T. latifolia
Urtica dioica

CHARACTERISTIC SPECIES II: open substrate of ditch banks, beds and adjacent berms

Anagallis arvensis
Atriplex patula
Cardamine oligosperma
Cotula coronopifolia
Echinochloa crusgalli
Epilobium ciliatum
Euphorbia peplis
Juncus bufonius
Nasturtium officinale
Paspalum dilatatum
Poa annua
Polypogon interruptus
P. monspeliensis
Rumex crispus
Sonchus oleraceus
Xanthium strumarium

CLASS: Emergent Wetland II - Saline Affinities
SUBCLASS: Persistent
WATER REGIME: Seasonally Flooded, Saturated
CHARACTERISTIC SPECIES: diked salt marsh and impounded ditches

Arthrocnemum subterminale
Atriplex patula
Distichlis spicata
Frankenia grandifolia
Lolium multiflorum
Parapholis incurva
Pennisetum clandestinum
Salicornia virginica
Xanthium strumarium

SUBCLASS: Nonpersistent and Persistent
WATER REGIME: Seasonally or Temporarily Flooded, Saturated
CHARACTERISTIC SPECIES: depressions, disturbed areas, tops of high berms (saline vernal wetlands)

Arthrocnemum subterminale
Avena fatua
Bassia hyssopifolia
Bromus diandrus
Cotula australis
C. coronopifolia
Distichlis spicata
Frankenia grandifolia
Hordeum geniculatum
Juncus bufonius
Lolium multiflorum
Mesembryanthemum nodiflorum
Parapholis incurva
Salicornia virginica
Spergularia marina
Suaeda calceoliformis

CLASS: Scrub/Shrub Wetland
SUBCLASS: Broadleaved, Deciduous and Evergreen
WATER REGIME: Seasonally or Temporarily Flooded, Saturated
CHARACTERISTIC SPECIES:

Baccharis glutinosa
B. pilularis
Salix lasiolepis

CLASS: Forested Wetland

SUBCLASS: Broadleaved Deciduous

WATER REGIME: Saturated, Temporarily Flooded

CHARACTERISTIC SPECIES* AND ASSOCIATES:

Artemisia douglasiana	Ribes menziesii
Epilobium ciliatum	Rubus ursinus
Euphorbia lathyris	Rumex conglomeratus
Juncus patens	R. salicifolius
Myoporum laetum	*Salix lasiolepis
Pittosporum undulatum	Solanum nigrum
Polygonum punctatum	Stachys bullata

A P P E N D I X III

ANNOTATED AND ILLUSTRATED CATALOGUE OF THE VASCULAR PLANTS

CARPINTERIA SALT MARSH

ANNOTATED AND ILLUSTRATED CATALOGUE OF VASCULAR PLANTS

This catalogue includes all native and naturalized vascular plants that were collected or observed during this study, collected by others during previous investigations, or reported in the literature from Carpinteria Salt Marsh and lower Carpinteria Creek and estuary. Cultivated plants are generally excluded. The catalogue is arranged according to a phylogenetic grouping of horsetails and angiosperms, and within the latter by dicotyledons and monocotyledons. Within all of these groups, the families, genera and species are listed in alphabetical order.

The information provided for each plant may include the following: scientific name and authorship; synonyms; common name; figure number; habit (annual, biennial, perennial herb, subshrub, shrub and tree) and occasional qualifying terms (e.g. succulent, suffrutescent, twining and parasitic); frequency/abundance; habitat; plant community or association; specific locality; "naturalized" if it is not native to the area but reproduces successfully, and "introduced and persistent" if it was apparently planted or discarded but persists on its own after cultivation; and voucher specimen or literature citations. Although much of the nomenclature is consistent with Munz (1959, 1968, 1974), many scientific names are according to more current manuals and authorities. In such cases, or when more current names have been proposed by others but not used herein, synonyms are provided that may assist with the recognition of taxa. Frequency refers to the general distribution of the plants within the study area (e.g. common, occasional, uncommon, rare), while abundance describes the relative number of individuals at any one site (e.g. abundant, common, scattered, rare). Habitat refers to the type of topographic or structural feature on which the plants grow (e.g. berms, dunes, flats, roadsides, alluvial fans, high marsh and debris piles). Plant community or association of species is that vegetation or grouping of plants that characterizes a particular habitat, and in which the taxon in question usually occurs (e.g. Disturbed Coastal Habitat, Coastal Scrub, Estuarine Emergent Wetland, and Palustrine Forested Wetland). Additional information is located in classification schemes containing lists of characteristic species provided for upland vegetation in APPENDIX I and wetland vegetation in APPENDIX II, and maps of the vegetation are presented in Figures 13 and 14a-c. Voucher specimens are listed by number only if collected by W.R. Ferren, Jr., and by collector and number, or by collector and date if specimen numbers were not available. Those plants cited in the H. Pollard card file, but for which no specimens have been located, include (CF) following the Pollard date of collection. Acronyms of the institutions in which vouchers are deposited are listed for all specimens except those at UCSB. Literature citations are given for those plants not observed during the study and for which no vouchers were seen by the author.

ANNOTATED AND ILLUSTRATED CATALOGUE

DIVISION TRACHEOPHYTA

SUBDIVISION SPENOPSIDA

CLASS EQUISETAE

EQUISETACEAE Horsetail Family

Equisetum hyemale L. var. affine (Engelm.) A. A. Eat. Scouring-Rush. Perennial herb; occasional/common; thicket at mouth of creek, depression on Carpinteria Ave.; Palustrine Emergent and Scrub/Shrub Wetlands; Carpinteria Salt Marsh and Creek; 2795; H. Pollard 15 Jul 1957 (CF).

Equisetum laevigatum A. Braun. Braun's Scouring-Rush. Perennial herb; uncommon/common; stream banks, flats at creek mouths; Palustrine Emergent Wetlands; Santa Monica and Carpinteria Creeks; 2800; H. Pollard 15 Aug 1955, 29 Jul 1957 (CF), 7 Mar 1959 (CAS, SBBG).

Equisetum telmateia Ehrh. var. braunii (Milde) Milde. Giant Horsetail. Fig. 36. Perennial herb; uncommon/abundant; irregularly flooded margin of estuary, seeps and ditches; Estuarine and Palustrine Wetlands; northwestern margin along railroad; 1731, 1777, H. Pollard 28 Feb 1959 (CAS, SBBG), J. Patman 1150 (SBBG), C. Smith 1935 (SBBG).

SUBDIVISION PTEROPSIDA

CLASS ANGIOSPERMAE

SUBCLASS DICOTYLEDONEAE

AIZOACEAE Carpet Weed Family

Carpobrotus aequilaterus (Haw.) N. E. Br. [Mesembryanthemum chilense Mol.] Sea Fig. Trailing succulent perennial; occasional/common; roadsides, dunes; Disturbed Coastal Habitat, Stabilized Dune; naturalized; 1943, C. Smith 1718 (SBBG).

Carpobrotus aequilaterus (Haw.) N. E. Br. X C. edulis (L.) Bolus. Trailing succulent perennial; occasional to common/common to abundant; berms, roadsides, debris piles, dunes, alluvial fans, high marsh; Disturbed Coastal Habitat, Coastal Scrub, Stabilized Dune, Estuarine Emergent Wetland; naturalized?; 1943, 1948b.

Carpobrotus edulis (L.) Bolus. [Mesembryanthemum edule L.]. Hottentot Fig. Trailing succulent perennial; occasional to common/common to abundant; berms, roadsides, debris piles, dunes, alluvial fans, high marsh; Disturbed Coastal Habitat, Coastal Scrub, Stabilized Dune, Estuarine Emergent Wetland; naturalized; 1794, 1948a, J. Patman 1139 (SBBG).

Drosanthemum floribundum (Haw.) Schwant. [Mesembryanthemum floribundum Haw.] Rosea Ice Plant. Trailing succulent perennial; rare/rare; roadsides; Disturbed Coastal Habitat; naturalized; 1939.

Malephora crocea (Jacq.) Schwant. Trailing succulent perennial; occasional/common to abundant; berms, high marsh; Disturbed Coastal Habitat, Estuarine Emergent Wetland; naturalized; 1724, 1862, 1964, 1965.

Mesembryanthemum nodiflorum L. Slender-Leaved Ice Plant. Fig. 37. Succulent annual; occasional/scattered to abundant; berms, dredge spoil, depressions; Disturbed Coastal Habitat; Palustrine Emergent Wetland; naturalized; 1593, 1847, 1848, 2208.

Tetragonia tetragonioides (Pallas) Kuntze. New Zealand Spinach. Succulent annual; occasional/scattered; berms, dredge spoil, high marsh; Disturbed Coastal Habitat, Estuarine Emergent Wetland; naturalized; 1856.

AMARANTHACEAE Amaranth Family

Amaranthus hybridus. Spleen Amaranth. Annual; occasional/scattered; margin of ditch along railroad; alluvial fans; Disturbed Coastal Habitat, Seasonally Flooded Palustrine Emergent Wetland; 2309.

Amaranthus powellii Wats. Powell's Amaranth. Annual; locally extirpated?; waste ground near mouth of Carpinteria Creek; Disturbed Coastal Habitat; H. Pollard 6 Oct 1958 (CF).

ANACARDIACEAE Sumac Family

Toxicodendron diversilobum (T. & G.) Greene. Poison Oak. Shrub; uncommon/scattered; bank between ditch and road, N of railroad; Disturbed Coastal Habitat, Coastal Scrub; no collection.

APIACEAE Celery Family

Apium graveolens L. Celery. Fig. 38. Annual or perennial; occasional/scattered to common; high marsh, ditches adjacent to railroad; Estuarine and Palustrine Emergent Wetlands; Carpinteria Salt Marsh and Creek; naturalized; 1957, 2078, H. Pollard 19 Jul 1957 (CF), J. Broughton 1157 (SBBG).

Berula erecta (Huds.) Cov. Cut-leaved Water Parsnip. Perennial herb; locally extirpated?; high marsh at mouth of creek; Estuarine and Palustrine Emergent Wetlands; Carpinteria Creek; H. Pollard 19 Jul 1957 (CAS).

Conium maculatum L. Poison Hemlock. Biennial herb; occasional to common/scattered to abundant; berms, roadsides, debris piles, alluvial fans, high marsh; Disturbed Coastal Habitats, Estuarine and Palustrine Emergent Wetlands; naturalized; 1814.

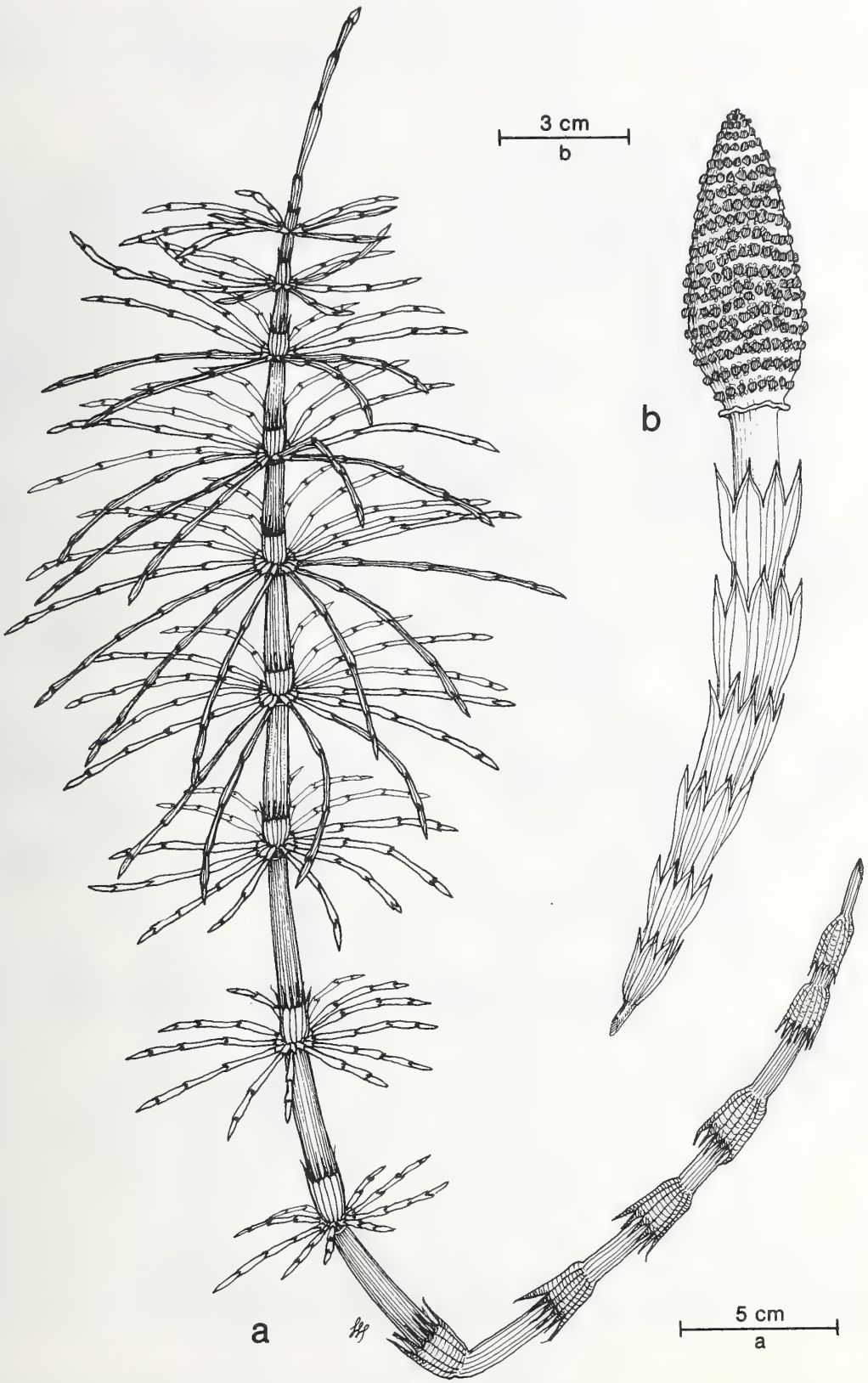


FIG. 36. *Equisetum telmateia* Ehrh. var. *braunii* Milde. Giant Horsetail.
a. Sterile stem with branches in whorls. b. Fertile stem with peduncled strobilus (cone).

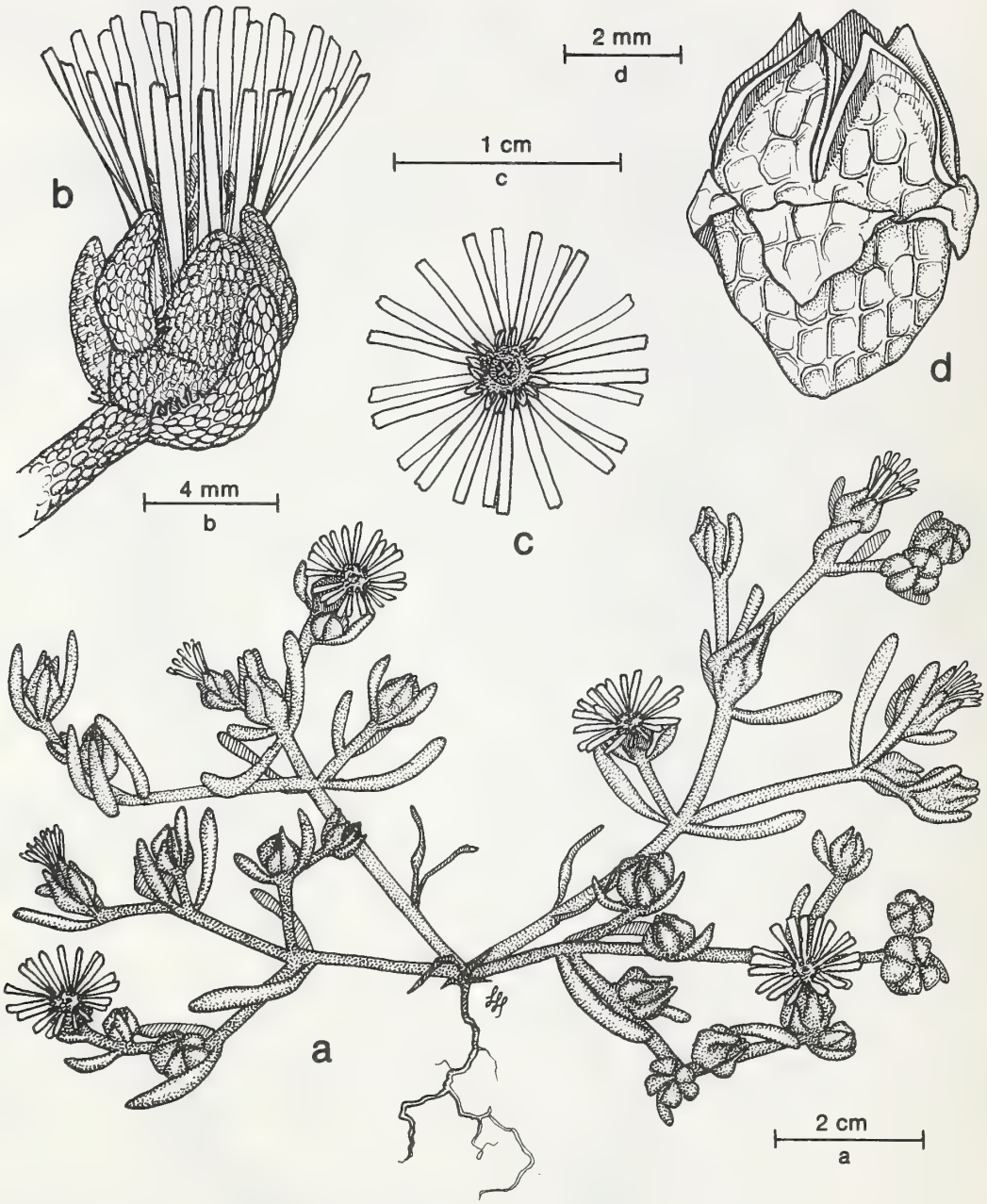


FIG. 37. *Mesembryanthemum nodiflorum* L. Iceplant.
a. Habit. b, c. Flower. d. Fruit (capsule).

Foeniculum vulgare L. Sweet Fennel. Perennial herb; occasional/scattered; berms, roadsides, debris piles; Disturbed Coastal Habitat; naturalized; 1977.

APOCYNACEAE Dogbane Family

Vinca major L. Periwinkle. Trailing perennial herb or subshrub; uncommon/common to abundant; debris piles, depressions adjacent to railroad; Disturbed Coastal Habitat; introduced and persistent; 1812.

ARALIACEAE Ginseng Family

Hedera helix L. English Ivy. Climbing or trailing shrub; uncommon/abundant; debris piles, railroad banks; Disturbed Coastal Habitat; introduced and persistent; 2260.

ASTERACEAE Sunflower Family

Ambrosia chamissonis (Less.) Greene. [A. chamissonis var. bipinnatisecta (Less.) J. T. Howell]. Silver Beachweed. Fig. 39. Perennial herb; occasional/scattered; sandy roadsides, dunes, banks of berms; Disturbed Coastal Habitat, Stabilized Dune, Irregularly Flooded Estuarine Emergent Wetland; Sand Point and Apple Rds. 1842, 1942, 2066, J. Patman 1126 (SBBG), R. Hoffmann 16 Jun 1925 (SBM).

Ambrosia psilostachya DC. var. californica (Rydb.) Blake. Western or Common Ragweed. Perennial herb; occasional to common/scattered to common; berms, roadsides, alluvial fans, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; 1617, 2067, H. Pollard 22 Oct 1950 (CAS).

Artemisia biennis Willd. Biennial Sagewort. Various coastal wetlands; Carpinteria; naturalized; C. Smith (1976).

Artemisia californica Less. Coastal Sagebrush. Fig. 40. Shrub; occasional/scattered to common; berms, roadsides, debris piles, alluvial fans, transitional wetlands; Disturbed Coastal Habitats, Coastal Scrub, Irregularly Flooded Estuarine Wetland; 1585, 1763.

Artemisia douglasiana Bess. in Hook. Douglas Mugwort. Perennial herb; occasional/scattered to common; berms, roadsides, alluvial fans, transitional wetlands; Disturbed Coastal Habitats, Coastal Scrub, Irregularly Flooded Estuarine and Palustrine Emergent Wetland; 1790, 2076.

Aster subulatus Michx. var. ligulatus Shinners [A. exilis Ell.]. Slim Aster. Fig. 41. Annual; berms, alluvial fans, ditches, transitional wetlands; Disturbed Coastal Habitats, Irregularly Flooded Estuarine Emergent Wetland, Palustrine Emergent Wetland; 1592, 1717, H. Pollard 21 Sep 1956 (CAS).

Baccharis douglasii DC. Salt Marsh Baccharis. Fig. 42. Subshrub; uncommon to occasional/scattered to common; high marsh, ditches; Irregularly Flooded Estuarine Emergent or Scrub/Shrub Wetland, Palustrine Emergent Wetland; 1732, 1773, Beeks 60, D. Breedlove 4046 (CAS),

H. Pollard 1 Aug 1962 (SBBG), M. Piehl 62436 (SBBG), J. Broughton 1152 (SBBG).

Baccharis glutinosa Pers. Mule Fat. Shrub; uncommon/scattered; alluvial fans, roadsides, ditches; Disturbed Coastal Habitat, Palustrine Wetlands; 1821, 2139.

Baccharis pilularis DC. ssp. consanguinea (DC.) C. B. Wolf. Coyote Brush. Fig. 43. Shrub; occasional to common/scattered to common; berms, roadsides, alluvial fans, debris piles; Disturbed Coastal Habitat; Coastal Scrub; Estuarine and Palustrine Scrub/Shrub Wetland; no specimen.

Carduus pycnocephalus L. Italian Thistle. Annual; occasional/scattered to abundant; berms, debris piles; Disturbed Coastal Habitat; naturalized; 1815, 1966a.

Centaurea melitensis L. Tecolote or Napa Thistle. Annual; occasional/scattered to common; berms, debris piles; Disturbed Coastal Habitat; naturalized; 1830, 1965b, 2209.

Conyza bonariensis (L.) Cronq. South American Conyza. Annual; occasional/scattered to common; berms, dredge spoil, roadsides; Disturbed Coastal Habitat; naturalized; 1719.

Conyza canadensis (L.) Cronq. var. canadensis. Horseweed. Annual; occasional to common/scattered to common; berms, dredge spoil, roadsides, alluvial fans; Disturbed Coastal Habitat; Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1718.

Cotula australis (Sieber ex Spreng.) Hook. f. Australian Cotula. Annual; uncommon/scattered to common; dredge spoil, vernal depressions; Disturbed Coastal Habitat, Seasonally Flooded Palustrine Emergent Wetland; naturalized; 2404.

Cotula coronopifolia L. Brass Buttons. Fig. 44. Perennial; berms, dredge spoil, vernal depressions, ditches; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally or Permanently Flooded Palustrine Emergent Wetlands; naturalized; 1600, 1755.

Dahlia imperialis Roezl. ex Ortg. Bell Tree or Tree Dahlia. Perennial herb; rare/rare; debris piles; Disturbed Coastal Habitat; introduced and not persistent; H. Pollard 8 Aug 1961 (CAS).

Euthamia occidentalis Nutt. [Solidago occidentalis (Nutt.) T. and G.]. Western Goldenrod. Fig. 45. Perennial herb; common/common; berms, debris piles, alluvial fans, ditches; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Wetlands; 2519, H. Pollard 22 Oct 1950 (CAS) and 26 Sep 1959 (SBBG), C. Smith 2465 (SBBG), H. and M. Dearing 2502 (SBBG).

Gazania linearis (Thunb.) Druce. Gazania. Perennial herb; rare/rare; debris pile; Disturbed Coastal Habitat; introduced and not persistent; 1851.

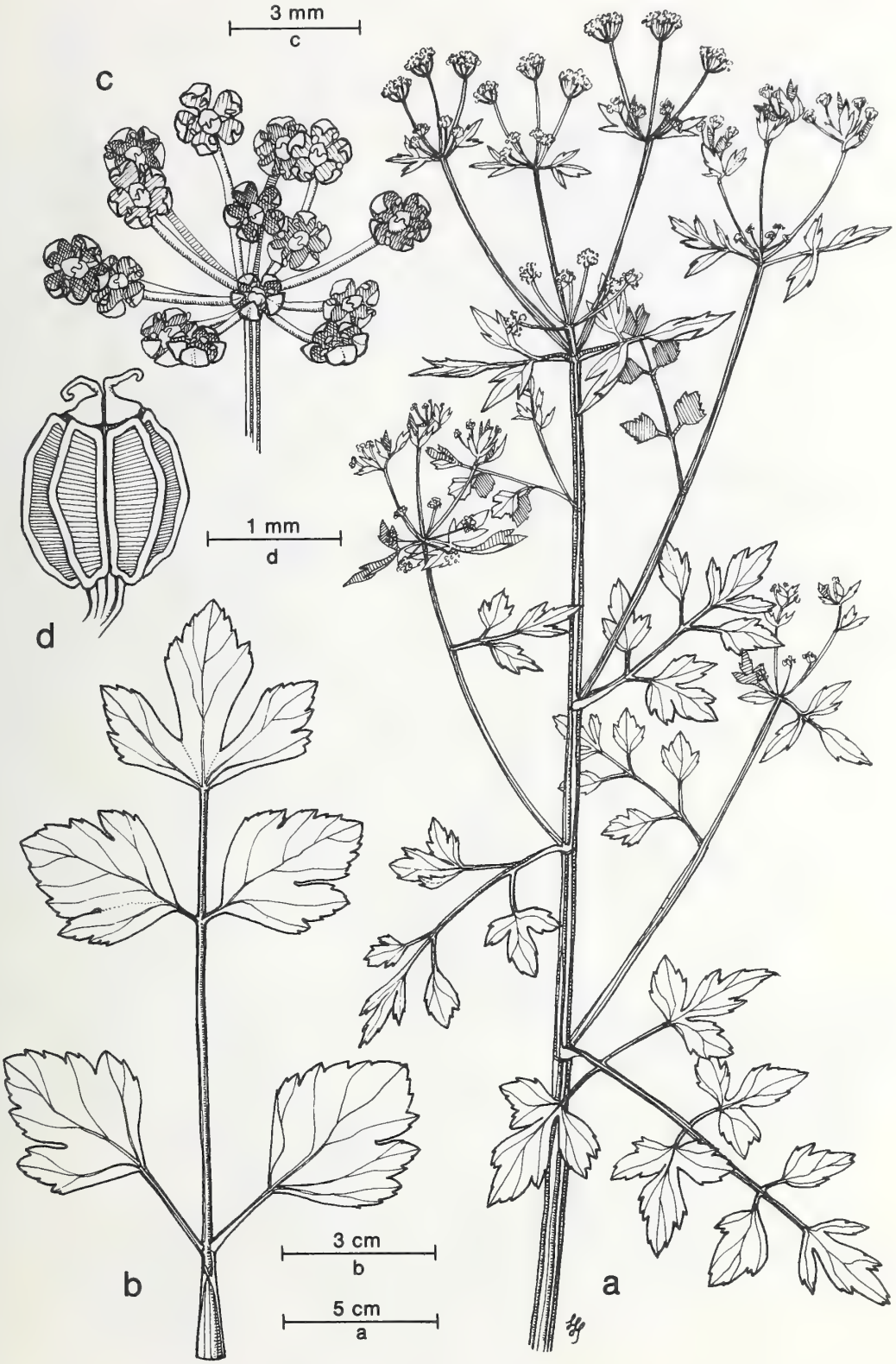


FIG. 38. *Apium graveolens* L. Celery
a. Upper stem. b. Leaf. c. Umbell of flowers. d. Fruit (2 mericarps).

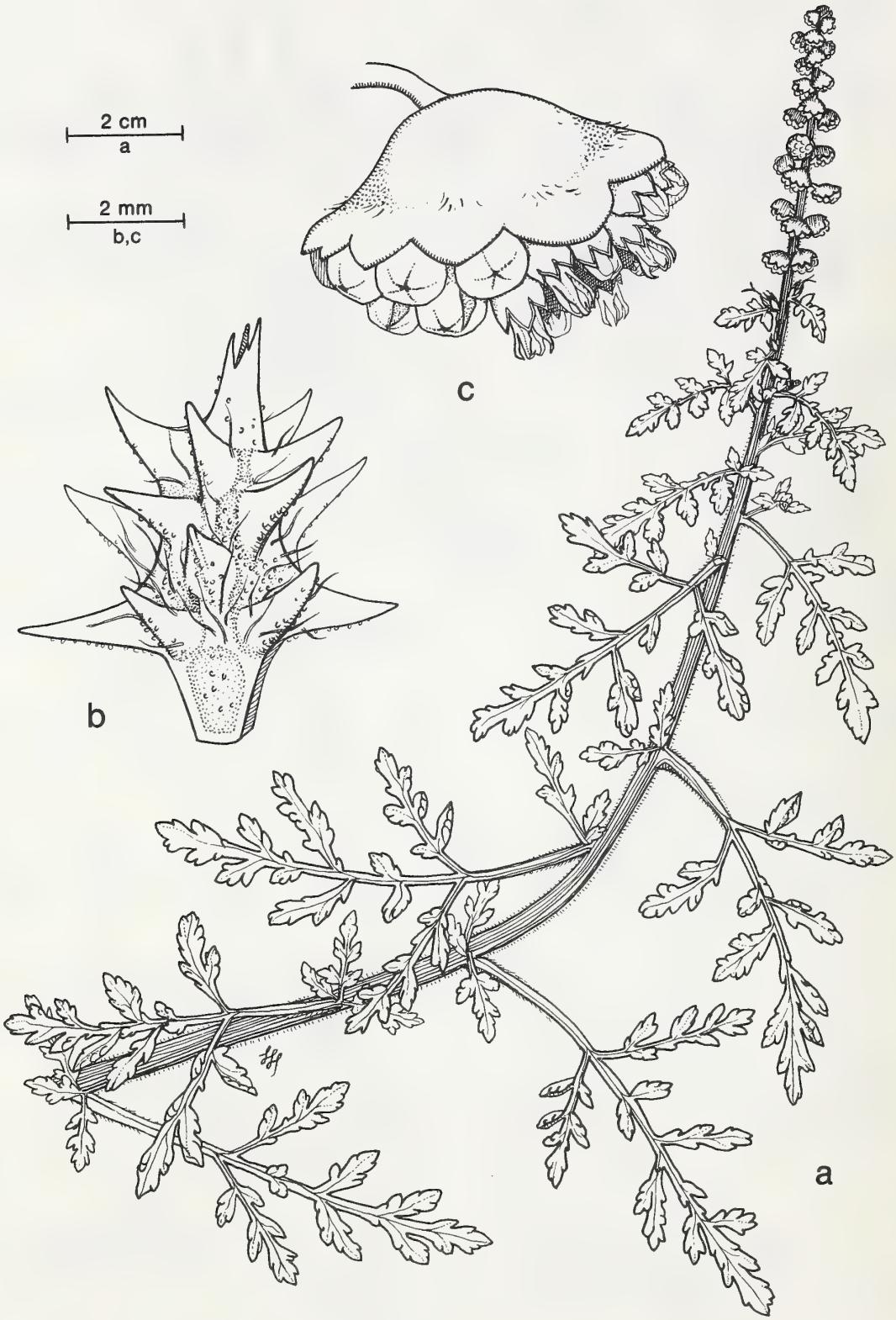


FIG. 39. *Ambrosia chamissonis* (Less.) Greene. Silver Beachweed.
a. Decumbent stem. b. Spiny involucre of mature pistillate flower. c. Capitulum (head) of staminate flowers.

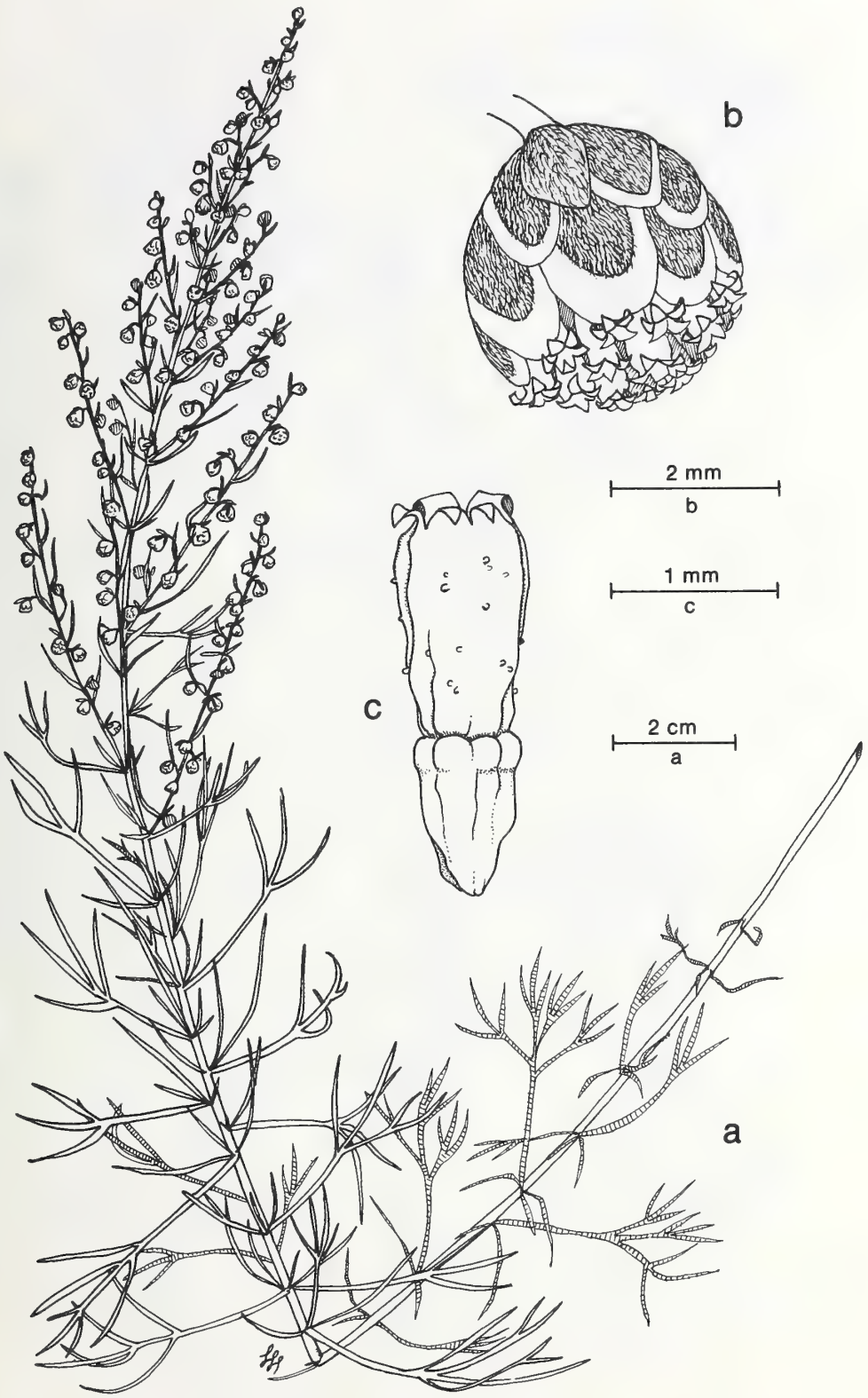


FIG. 40. *Artemisia californica* Less. Coastal Sagebrush.
a. Branch. b. Capitulum. c. Flower with developing achene.

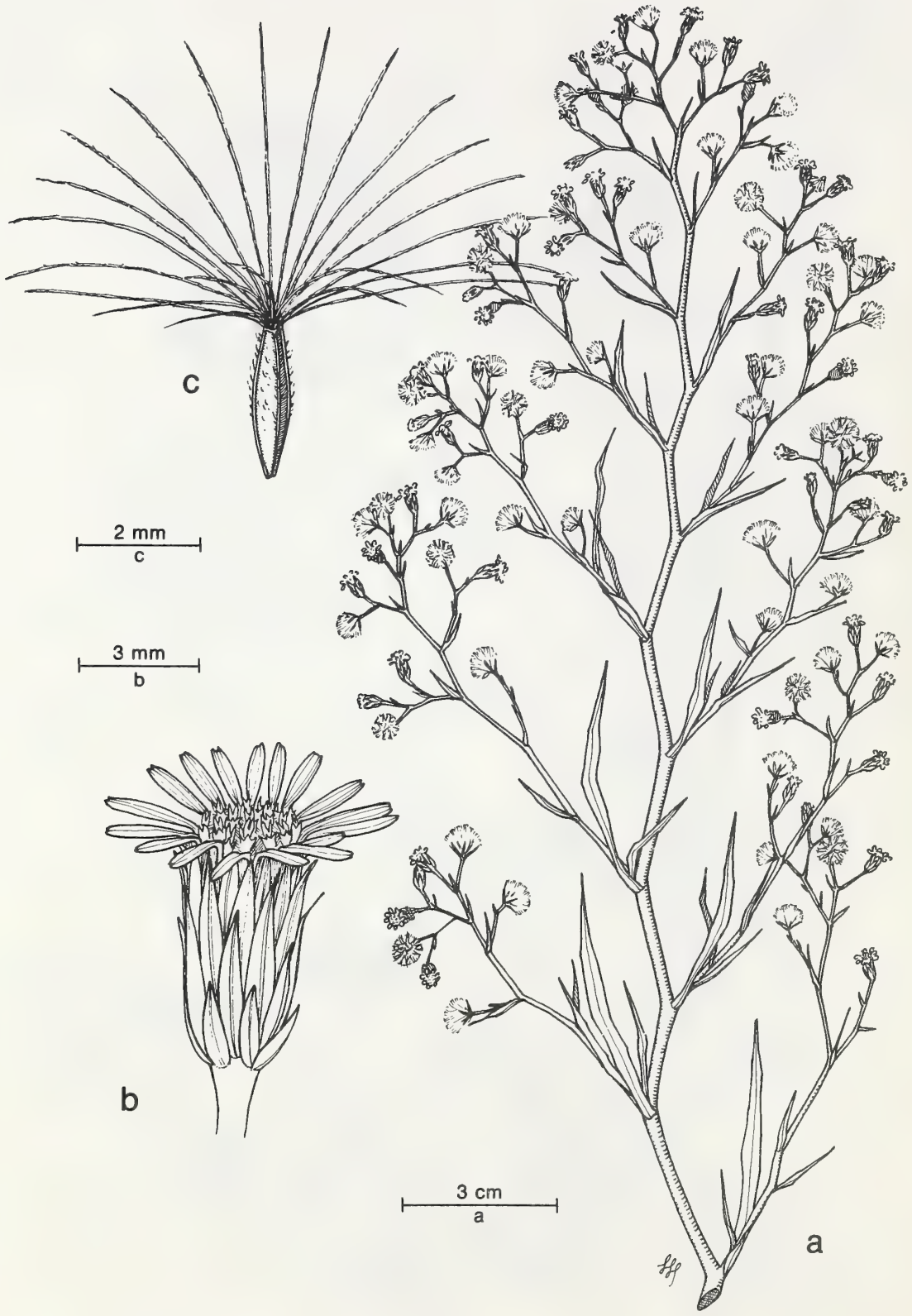


FIG. 41. *Aster subulatus* Michx. var. *ligulatus* Shinners. Slim Aster.
a. Upper stem, arrangement of capitula. b. Capitulum. c. Achene with bristles.

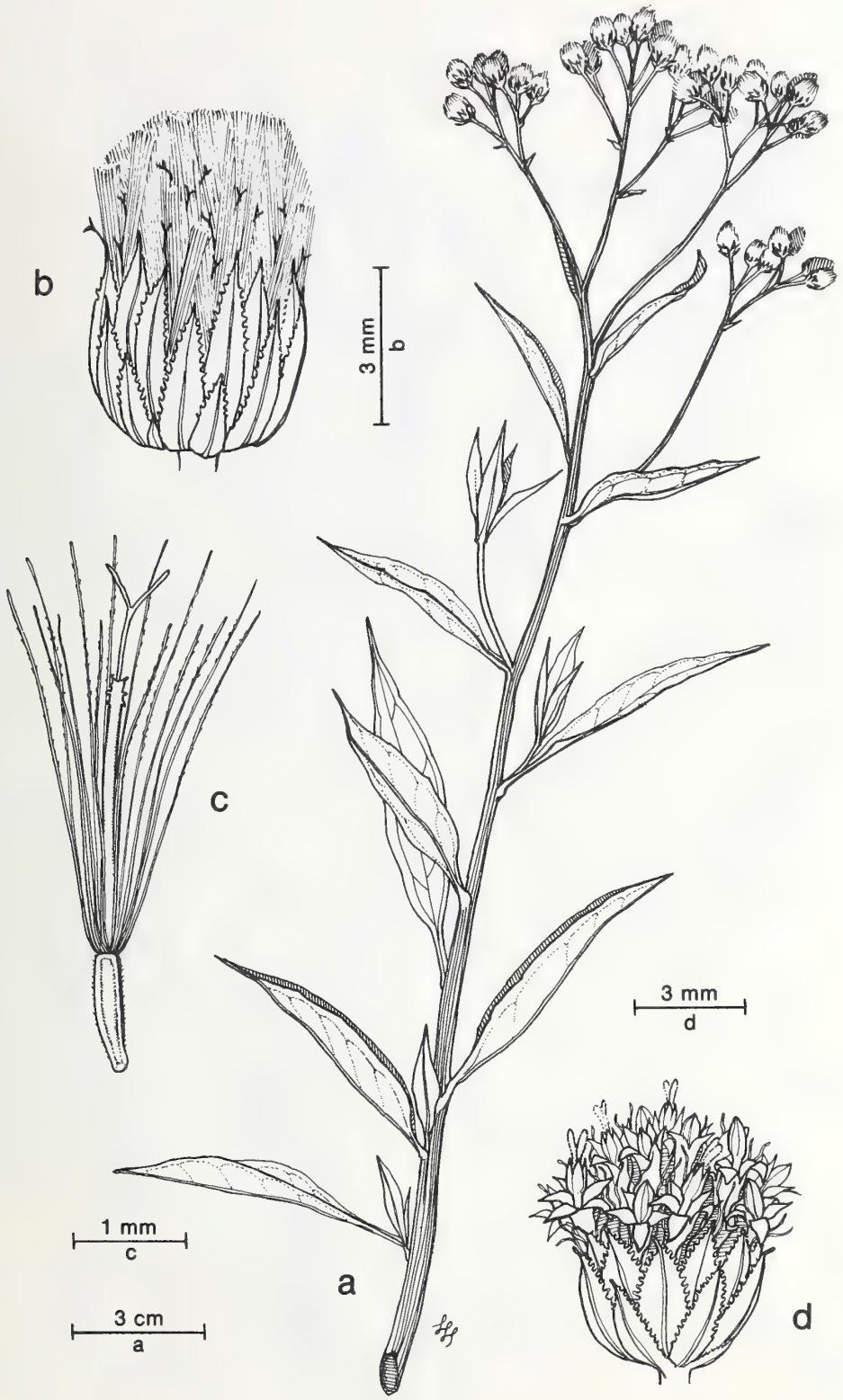


FIG. 42. *Baccharis douglasii* DC. Salt Marsh Baccharis.
a. Upper stem, arrangement of capitula, female plant. b. Capitulum of pistillate flowers. c. Pistillate flower with bristles and developing achene. d. Capitulum of staminate flowers.



FIG. 43. *Baccharis pilularis* DC. ssp. *consanguinea* (DC.) C. B. Wolf. Coyote Brush. a. Branch, arrangement of capitula, female plant. b. Capitulum of pistillate flowers. c. Pistillate flower with bristles and developing achene. d. Capitulum of staminate flowers.

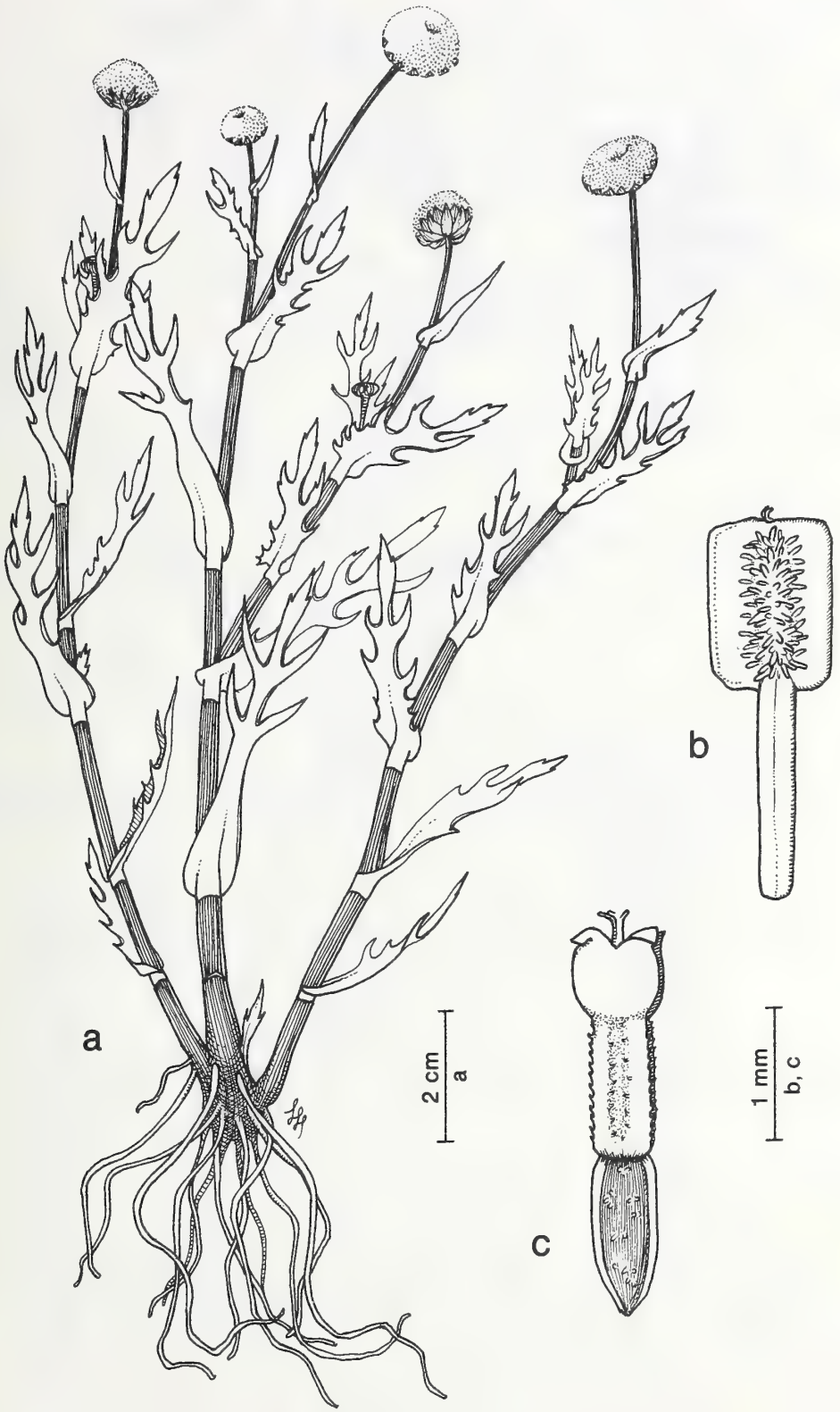


FIG. 44. *Cotula coronopifolia* L. Brass Buttons.
a. Habit. b. Outer flower pedicellate and pistillate. c. Disk flower.

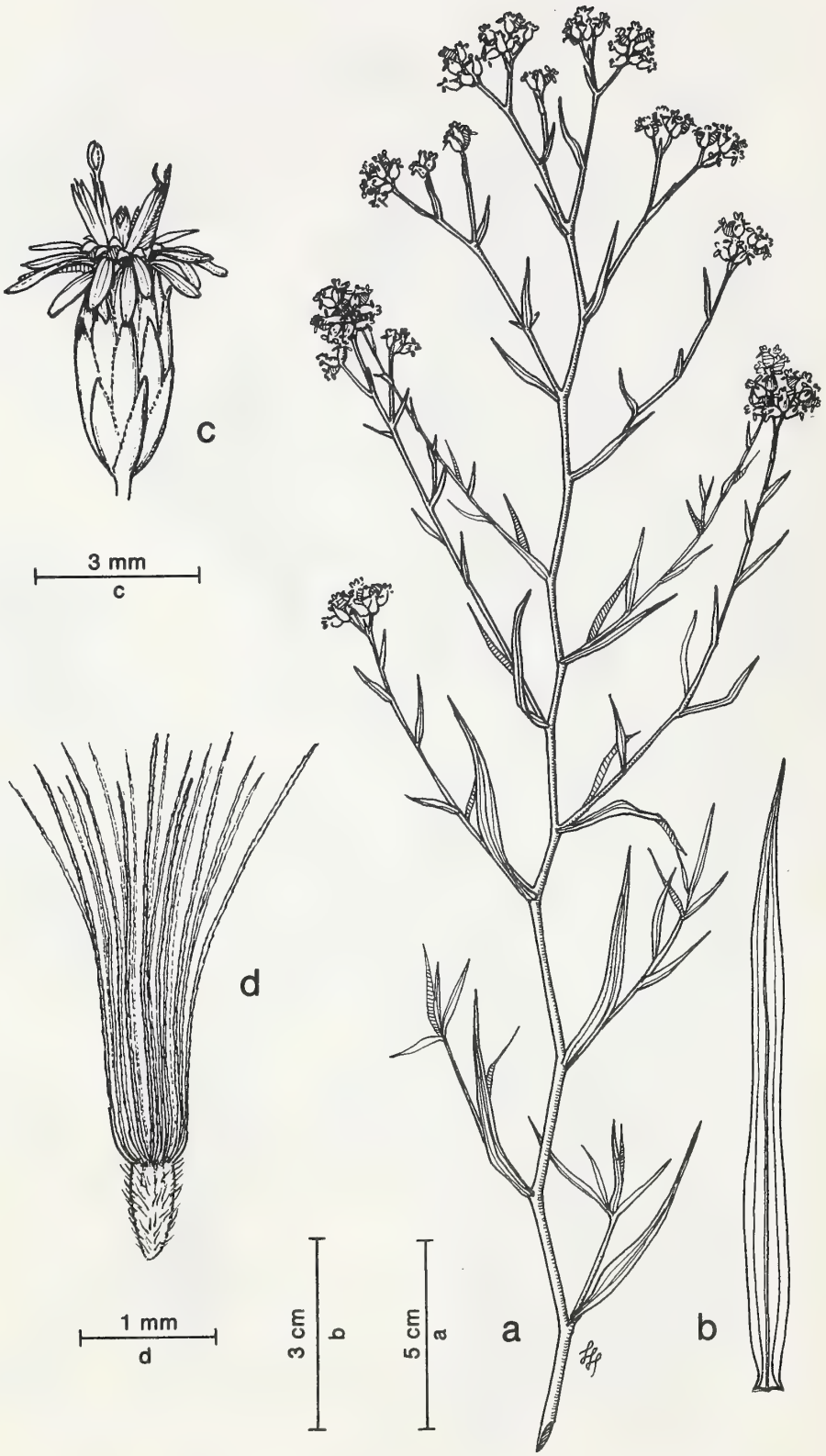


FIG. 45. *Euthamia occidentalis* Nutt. Western Goldenrod.
a. Upper stem and arrangement of capitula. b. Leaf. c.Capitulum. d. Achene with bristles.

Gnaphalium californicum DC. Green Everlasting. Biennial; occasional/-scattered; berms; Disturbed Coastal Habitat, Coastal Scrub; 1846.

Gnaphalium chilense Spreng. var. chilense. Cotton-Batting Plant. Annual or biennial; occasional/scattered; berms, roadsides, stream banks; Disturbed Coastal Habitat, Coastal Scrub; 1591, 1849, 1982, 2199, H. Polland 1 Aug 1962 (SBBG). J. Patman 1156 (SBBG), J. Broughton 1156 (SBBG).

Gnaphalium luteo-album L. Weedy Cudweed. Annual; occasional/scattered; berms, vernal depressions, ditches, streambeds; Disturbed Coastal Habitat, Seasonally Flooded Palustrine Emergent Wetland; naturalized; 1824, 1845, H. Pollard 1 Aug 1962 (SBBG).

Gnaphalium microcephalum Nutt. var. microcephalum. White Everlasting. Biennial or perennial herb; uncommon to occasional/scattered; berms; Disturbed Coastal Habitat, Coastal Scrub; 1845.

Hazardia squarrosa (H. & A.) Greene var. grindelioides (DC.) Clark. [Haplopappus squarrosus H. & A. ssp. grindelioides (DC.) Keck.] Sawtooth Goldenbush or Common Hazardia. Shrub; rare/rare; railroad bank; Disturbed Coastal Habitat; H. Pollard 8 Aug 1961 (SBBG).

Helenium puberulum DC. Sneezeweed or Rosilla. Annual or perennial; locally extirpated?; marsh at mouth of creek; Palustrine Emergent Wetland; Carpinteria Creek; H. Pollard 19 Jul 1957 (CF).

Helianthus annuus L. Sunflower. Annual; uncommon/scattered?; railroad bank; Disturbed Coastal Habitat; naturalized?; H. Pollard 21 Sep 1957 (CAS).

Hemizonia fasciculata (DC.) T. & G. [H. ramosissima Benth.] Fascicled Tarweed. Annual; occasional/scattered to abundant; berms; vernal depressions; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; 1729, 1868.

Heterotheca grandiflora Nutt. Telegraph Weed. Fig. 46. Annual or biennial; occasional to common/scattered to common; berms, roadsides; transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; no specimen.

Hypochoeris glabra L. Smooth Cat's Ear. Annual; uncommon/scattered; berms, roadsides; Disturbed Coastal Habitat; naturalized; 1863.

Isocoma veneta (HBK.) Greene var. vernonioides (Nutt.) Jeps. Coast Goldenbush. [Haplopappus venetus (HBK.) Blake ssp. vernonioides (Nutt.) Hall.] Fig. 47. Shrub; occasional to common/scattered to common; berms, roadsides, debris piles, alluvial fans, high marsh; Disturbed Coastal Habitat, Coastal Scrub, Irregularly Flooded Estuarine Emergent and Scrub/Shrub Wetland; 1590, 2069, R. Beeks 51, H. Pollard 13 Sep 1963 (SBBG).

Jaumea carnosa (Less.) Gray. Jaumea. Fig. 48. Perennial herb; occasional to common/common to abundant; middle to high marsh;

Irregularly Flooded Estuarine Emergent Wetland. 1584, 1953, 1962, Mason 4111 (UC), D. Breedlove 4036 (DS), H. Pollard 17 Jul 1959 (CAS, SBBG) and 1 Aug 1962 (CAS), J. Patman 1159 (SBBG), J. Broughton 1158 (SBBG), H. and M. Dearing 2440 (SBBG).

Lactuca serriola L. Wild Lettuce. Annual; occasional/scattered; berms, roadsides; Disturbed Coastal Habitat; naturalized; 1974a and b, H. Pollard 26 Sep 1959 (CF).

Lasthenia glabrata Lindl. ssp. coulteri (Gray) Ornduff. Salt Marsh Daisy. Fig. 48. Annual; uncommon/scattered to abundant; alluvial fans, sandbars in marsh; Irregularly Flooded Estuarine Emergent Wetland; alluvial fan of Santa Monica Creek, and along Sand Point Rd.; 1952, 2385a and b, H. and M. Dearing 2442 (SBBG), C. Smith 1891 and 1892 (SBBG, SBM), E. Brauton 1280 (UC), R. Hoffman 30 May 1925 (SBM).

Malacothrix incana (Nutt.) T. & G. var. incana. Dune Malacothrix. Suffrutescent perennial herb; locally extirpated? (last collected in 1948); dunes; Partially Stabilized and Stabilized Dune; H. and M. Dearing 2482 (UCSB, UC, SBBG), G. Stebbins 2654 (UC), H. Copeland 19 Jun 1938 (CAS), C. Smith 2281 (SBBG, SBM).

Malacothrix incana (Nutt.) T. & G. aff. var. succulenta (Elmers) Williams. Succulent Dune Malacothrix. Perennial herb; locally extirpated? dunes, between salt marsh and dunes; Partially Stabilized and Stabilized Dune; R. Hoffmann 30 May 1925, 15 Mar 1930 (SBM).

Malacothrix saxatilis (Nutt.) T. & G. var. tenuifolia (Nutt.) Gray. Cliff Aster. Suffrutescent perennial herb or subshrub; occasional/scattered; berms; Disturbed Coastal Habitat, Coastal Scrub; 1831, J. Broughton 1155 (SBBG).

Osteospermum fruticosum (L.) Norl. Freeway Daisy. Perennial herb; uncommon/scattered; banks of berms, high marsh; Irregularly Flood Estuarine Wetland; naturalized; 1764.

Picris echioides L. Ox Tongue. Biennial; occasional/scattered to common; berms, ditches, vernal depressions; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1587.

Senecio vulgaris L. Common Groundsel. Annual; occasional/scattered to common; berms, dredge spoil, ditches, vernal depressions; Disturbed Coastal Habitats, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1765, 2191.

Silybum marianum (L.) Gaertn. Milk Thistle. Biennial; uncommon to occasional/scattered; berms; Disturbed Coastal Habitat; naturalized; 1785.

Solidago californica Nutt. California Goldenrod. Perennial herb; locally extirpated?; along railroad W of and near Sandyland; H. Pollard 15 Sep 1957 (CAS).

Solidago confinis Gray. Southern Goldenrod. Perennial herb; locally extirpated? (not seen here since 1959); low ground bordering salt marsh along railroad; Palustrine Emergent Wetland?; H. Pollard 22 Oct 1950 (SBM), 15 Sep 1957 (CAS) and 26 Sep 1959 (SBBG), C. Smith 22 Oct 1950 (SBBG).

Sonchus asper (L.) Hill. Prickly Sow-Thistle. Annual; occasional/scattered; berms, dredge spoil, roadsides; Disturbed Coastal Habitat; naturalized; 1839.

Sonchus oleraceus L. Common Sow-Thistle. Annual; occasional to common/scattered to common; berms, dredge spoil, roadsides, ditches; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1756, 1770, 1840, 2192, M. Piehl 62430 (SBBG).

Stephanomeria exigua Nutt. ssp. coronaria (Greene) Gottlieb. Small Stephanomeria. Annual; locally extirpated?; sandy places E of and near Carpinteria Creek; H. Pollard 6 Oct 1958 (CAS); C. Smith 5865 (SBBG).

Tragopogon porrifolius L. Salsify or Oyster Plant. Perennial herb; occasional/scattered; berms; Disturbed Coastal Habitat; naturalized; 1827.

Venegasia carpesioides DC. Canyon Sunflower. Shrub; rare/rare; Meyers (1974).

Xanthium spinosum L. Spiny Clotbur or Spanish Thistle. Annual; occasional/scattered?; roadsides; Disturbed Coastal Habitat; introduced and not persistent?; H. Pollard 21 Sep 1957 (CF), Meyers (1974).

Xanthium strumarium L. var. canadense (P. Mill.) T. & G. Cocklebur. Annual; occasional/scattered to common; ditches along railroad; Seasonally Flooded Palustrine Emergent Wetland; no collection.

BASELLACEAE Basella Family

Anredera cordifolia (Ten.) Steenis. [Boussingaultia gracilis Miers var. pseudobaselloides (Haumen) Bailey]. Madeira Vine. Climbing perennial herb; uncommon; ditch along railroad; Palustrine Emergent Wetland; introduced and not persistent?; UCSB Bot. Soc. 32.

BORAGINACEAE Borage Family

Amsinckia spectabilis F. & M. var. spectabilis. Seaside Amsinckia. Annual; locally extirpated?; sandy places E of and near Carpinteria Creek; Stabilized Dune; Disturbed Coastal Habitat; H. Pollard 27 Mar 1960 (SBBG).

Heliotropium curassavicum L. ssp. occulatum (Heller) Thorne. Seaside Heliotrope. Fig. 49. Prostrate perennial herb; common/scattered to common; berms, roadsides, alluvial fans, dunes, transitional wetlands; Disturbed Coastal Habitat; Cismontane Introduced Grasses; Stabilized

Dune; Irregularly Flooded Estuarine Emergent Wetland; 1767, 1865; J. Patman 1130 (SBBG), R. Hoffmann 2 May 1925 (SBM).

BRASSICACEAE Mustard Family

Brassica geniculata (Desf.) L. Ball. Biennial or perennial herb; common/scattered to common; berms, dredge spoil, roadsides, debris piles; Disturbed Coastal Habitat; naturalized; 1832.

Brassica nigra (L.) Koch. Black Mustard. Annual; occasional/scattered to common; berms, dredge spoil, debris piles, alluvial fans; Disturbed Coastal Habitat; Cismontane Introduced Grasses; naturalized; 1850, 2195.

Brassica rapa L. ssp. sylvestris. Field Mustard. Annual; occasional/scattered; berms, debris piles, roadsides; Disturbed Coastal Habitat; naturalized; 1776.

Cakile maritima Scop. Sea Rocket. Fig. 50. Annual; occasional to common/scattered; berms, dunes, high marsh; Partially Stabilized Dune, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1586, 1766.

Cardamine oligosperma Nutt. Few-Seeded Bitter-Cress. Annual or biennial; uncommon/scattered; berms, ditches along railroad; Disturbed Coastal Habitat, Palustrine Emergent Wetland; 1780, 2545a.

Coronopus didymus (L.) Sm. Wart-Cress. Annual or biennial; occasional/scattered; berms, dredge spoil; Disturbed Coastal Habitat; naturalized; 2394.

Descurainia pinnata (Walt.) Britton ssp. menziesii (DC.) Detl. Tanzy Mustard. Annual; occasional/scattered; berms; Disturbed Coastal Habitat; 2751.

Hymenolobus procumbens (L.) Nutt. ex T. & G. [Hutchinsia procumbens (L.) Desv.]. Fig. 51. Annual; uncommon/common to abundant; alluvial fans, high marsh; Irregularly Flooded Estuarine Emergent Wetland; 2392.

Lepidium virginicum L. var. pubescens (Greene) C. L. Hitchc. Wild Pepper-Grass. Annual; uncommon/scattered; berms; roadsides; Disturbed Coastal Habitat; naturalized; 1829.

Nasturtium officinale R. Br. [Rorippa nasturtium-aquaticum (L.) Hayek]. Water Cress or Berros. Fig. 52. Perennial herb; occasional to common/common; ditches along railroad; streambed of Carpinteria Creek; Riverine and Palustrine Emergent Wetlands; naturalized; 2265, 2411, Ferren and Whitmore 18 Jul 1979, UCSB Bot. Soc. 28.

Raphanus sativus L. Wild Radish. Annual; occasional to common/scattered to common; berms, alluvial fans, transitional wetlands; Disturbed Coastal Habitat, Cismontane Introduced Grasses; Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1759, 1969, 2194.

Sisymbrium irio L. London Rocket. Annual; occasional to common/scattered; berms; Disturbed Coastal Habitat; 2752.

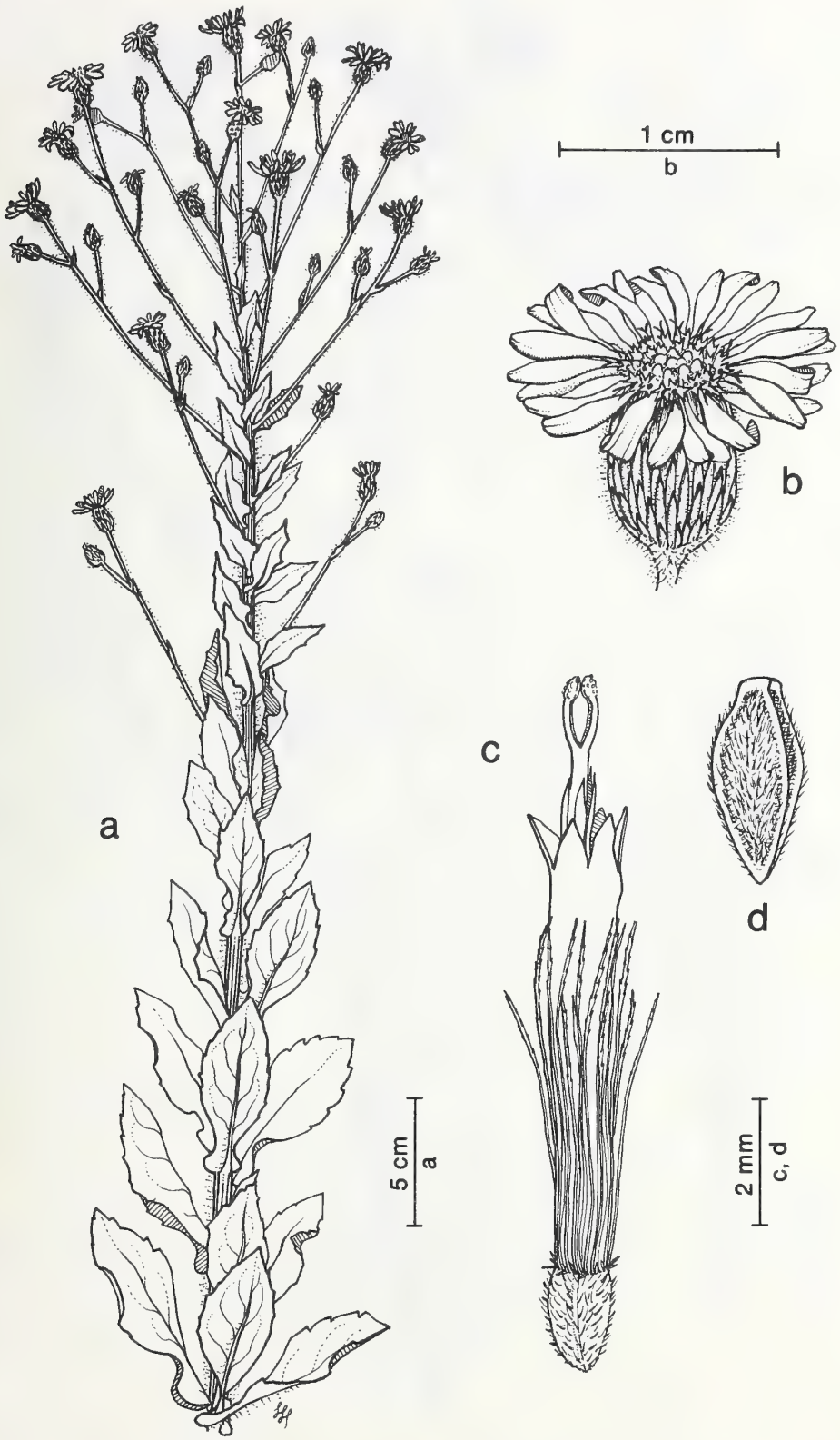


FIG. 46. *Heterotheca grandiflora* Nutt. Telegraph Weed.
a. Habit. b. Capitulum. c. Flower with bristles and developing achene.
d. Achene.

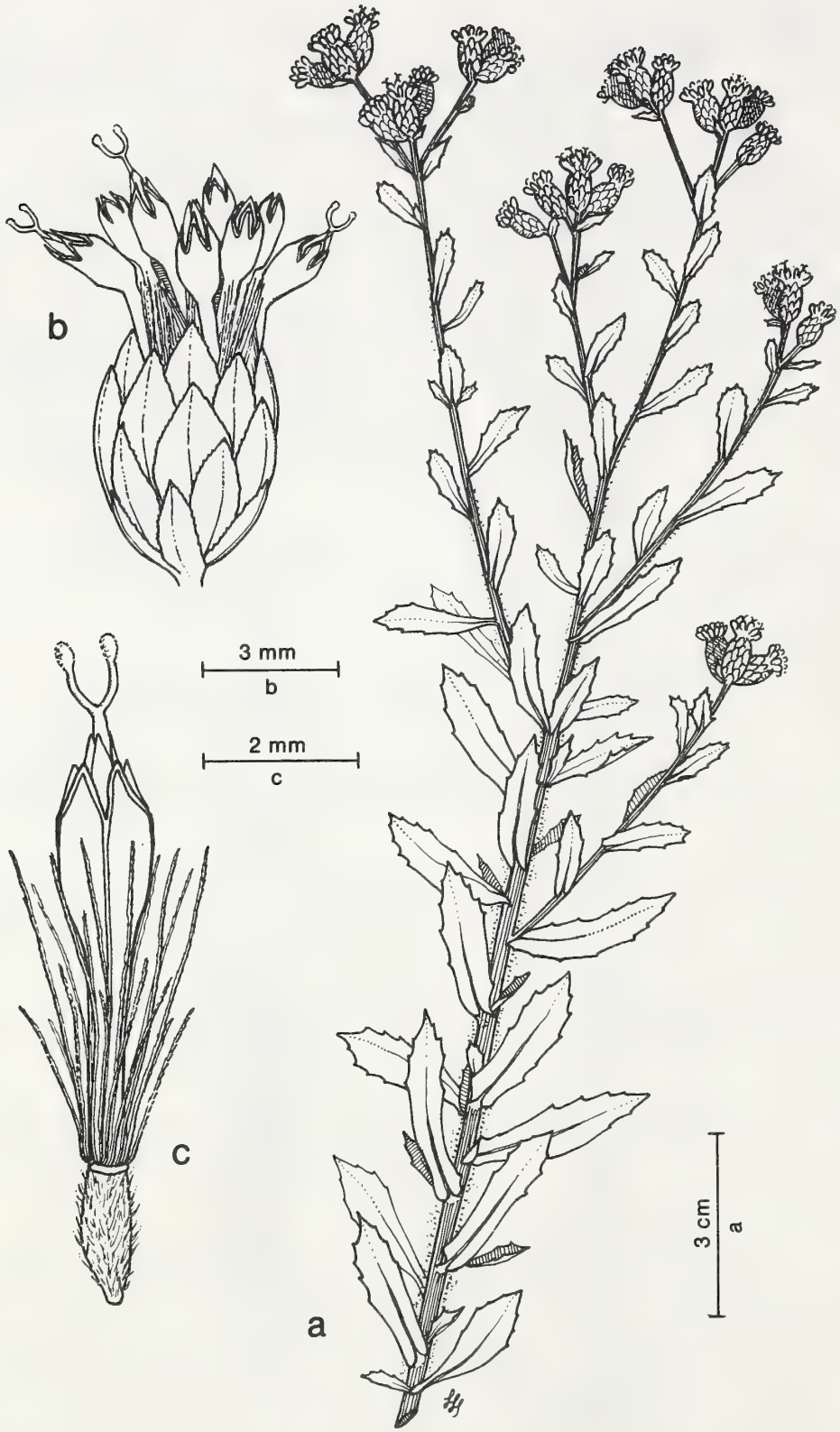


FIG. 47. *Isocoma veneta* (HBK.) Greene var. *vernonioides* (Nutt.) Jeps. Coast Goldenbush. a. Stem, arrangement of capitula. b. Capitulum. c. Flower with bristles and developing achene.



FIG. 48. *Jaumea carnosa* (Less.) Gray. Jaumea.
a. Habit. b. Flower with developing achene. *Lasthenia glabrata* Lindl. ssp. *coulteri* (Gray) Ornduff. Salt Marsh Daisy. c. Habit. d. Flower with developing achene.



FIG. 49. *Heliotropium curassavicum* L. ssp. *occulatum* (Heller) Thorne. Seaside Heliotrope. a. Habit. b. Inflorescence. c. Fruit (nutlets).

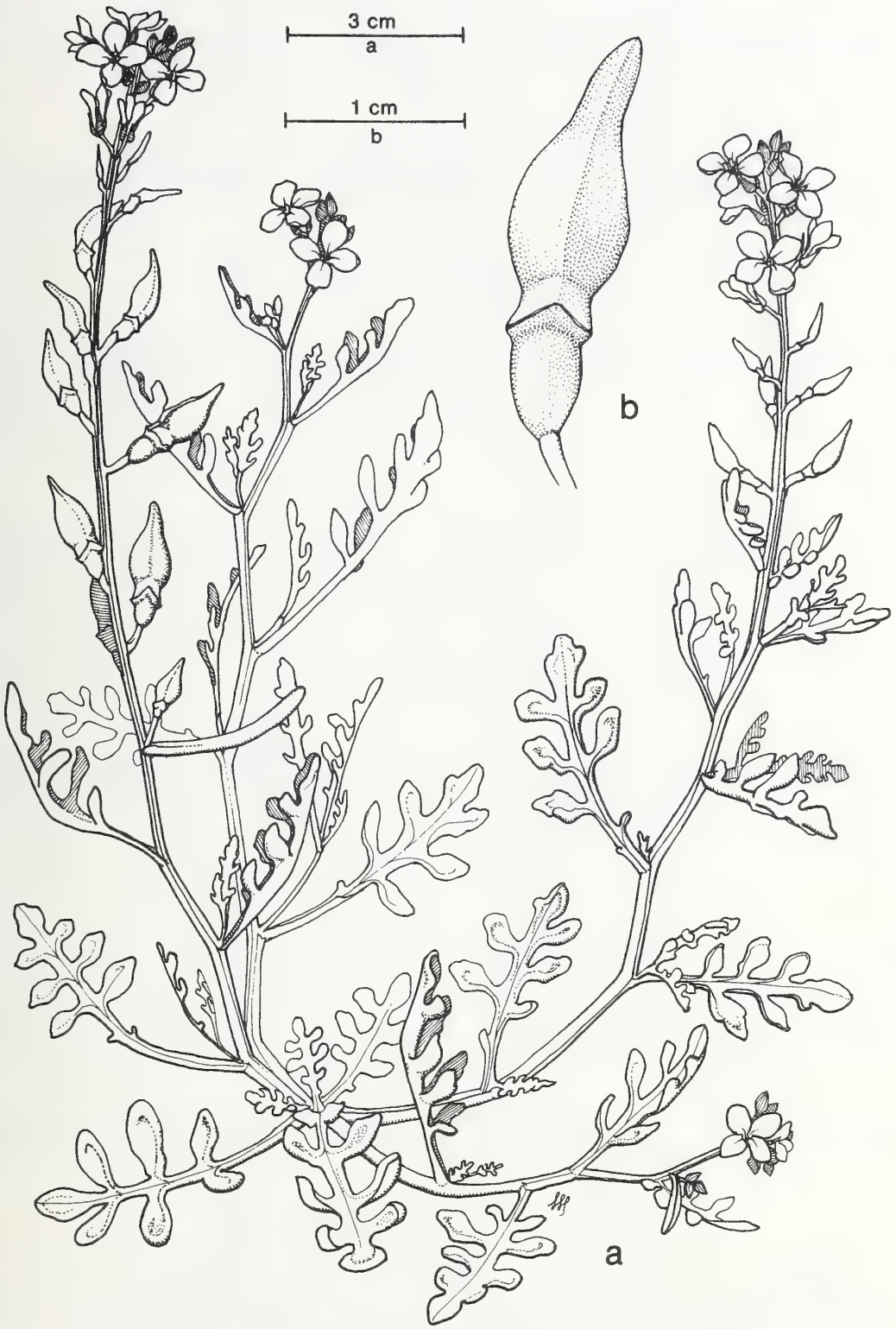


FIG. 50. *Cakile maritima* Scop. Sea-Rocket. a. Habit. b. Fruit (silicle).

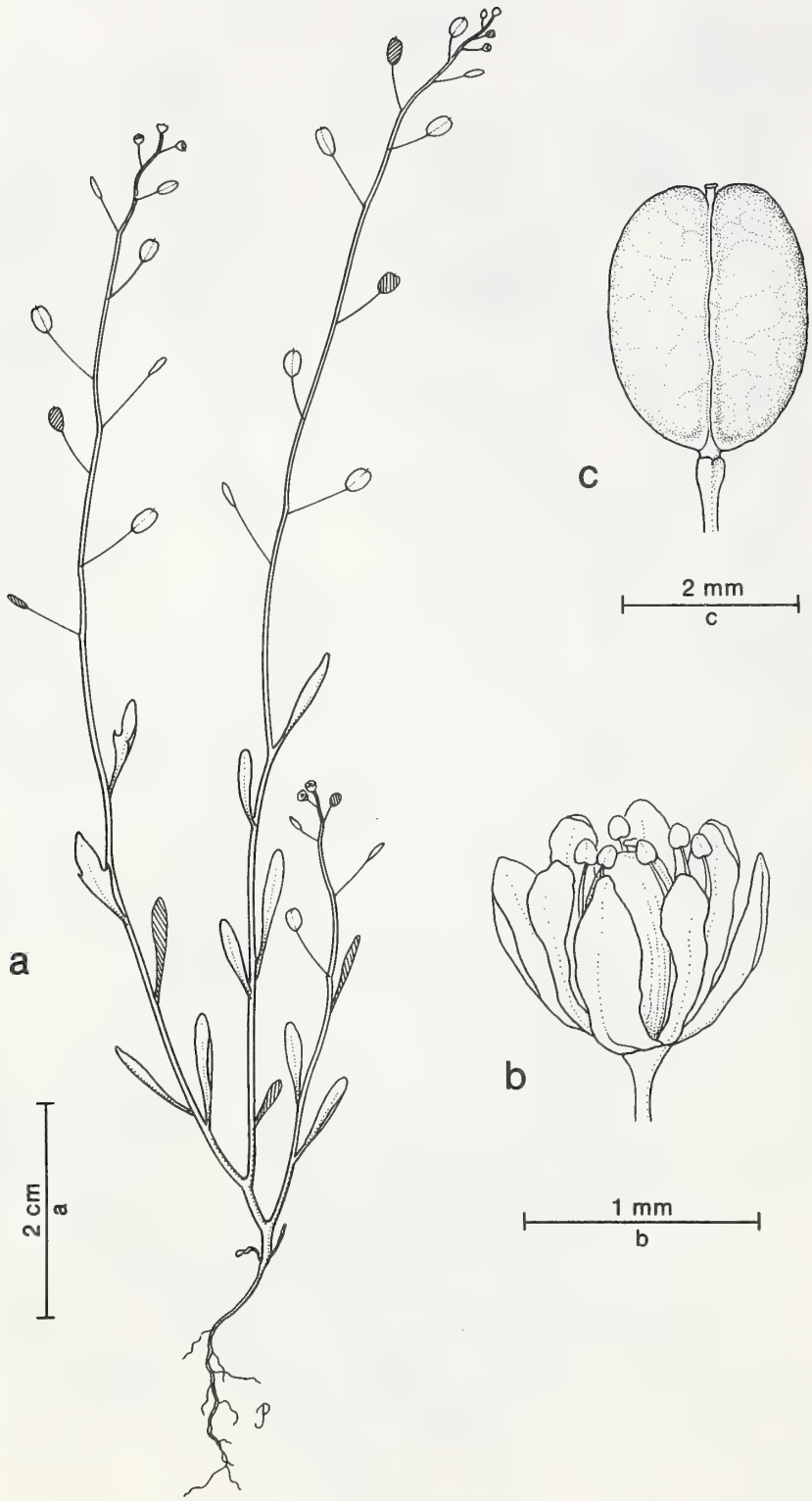


FIG. 51. *Hymenolobus procumbens* (L.) Nutt. ex T. and G.
a. Habit. b. Flower. c. Fruit (silicle).

Sisymbrium orientale L. Oriental Sisymbrium. Annual; occasional/scattered; berms, dredge spoil; Disturbed Coastal Habitat; naturalized; 1835, 2397.

CACTACEAE Cactus Family

Opuntia basilaris Engelm. Beavertail Cactus. Succulent shrub; rare/rare; debris pile; Disturbed Coastal Habitat; introduced and persistent; 2316.

CAPRIFOLIACEAE Honeysuckle Family

Sambucus mexicana Presl ex DC. Southwestern or Desert Elderberry. Shrub or small tree; occasional/scattered; berms, alluvial fans, diked marshes; Disturbed Coastal Habitat, Coastal Scrub, Palustrine Emergent or Scrub/Shrub Wetlands; 1963, 1967.

CARYOPHYLLACEAE Pink Family

Silene gallica L. Common Catchfly. Annual; occasional/scattered; berms, dredge spoil, high or transitional marsh; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1799.

Spergularia bocconii (Scheele) Aschers & Graebr. Boccone's Sand Spurry. Annual; uncommon/scattered; berms, dredge spoil; Disturbed Coastal Habitat; naturalized; 2204a, 2400.

Spergularia macrotheca (Hornem.) Heynh. var. macrotheca. Large-Flowered Sand Spurry. Fig. 53. Perennial herb; uncommon to occasional/scattered to common; berms, dredge spoil, sandbars in marsh, high marsh; Disturbed Coastal Habitat; Irregularly Flooded Estuarine Emergent Wetland; 1804, 1951, 2064, 2363, R. Hoffman-Hoffman 30 May 1925 (SBM).

Spergularia marina (L.) Griseb. Salt Marsh Sand Spurry. Fig. 53. Annual; common/scattered to abundant; berms, dredge spoil, alluvial fans, salt flats, middle to high marsh, vernal depressions, ditches, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; 1581, 1760, 2148, 2240b & c, 2391, 2405a, J. Patman 1134 (SBBG).

Stellaria media (L.) Vill. Common Chickweed. Annual; occasional/scattered to common; berms; Disturbed Coastal Habitat; naturalized; 1793.

CHENOPODIACEAE Goosefoot Family

Arthrocnemum subterminale (Parish) Standl. [Salicornia subterminalis Parish]. Parish's Glasswort. Fig. 54. Suffrutescent perennial herb; occasional to common/scattered to abundant; berms, alluvial fans, salt flats, transitional wetlands, sandbars in marsh, high marsh, diked marsh; Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; 1946, 2061, H. Pollard 15 Aug 1955 (CAS) and 1 Aug 1962 (CAS, SBBG), R. Thorne and P. Everett 11 Aug 1965 (CAS, RSA), D. Breedlove 4033 (DS), C. Smith 1889 (SBBG), J. Patman 1135 (SBBG).

Atriplex californica Moq. in DC. California Saltbush. Fig. 55. Perennial herb or subshrub; occasional/scattered to common; berms, sandbars in marsh, transitional wetland; Irregularly Flooded Estuarine Emergent Wetland; banks of Apple Rd. and sandbars along Sand Point Rd.; 1727, 1758, C. Smith 2003 (SBBG), M. Piehl 62445 (RSA).

Atriplex lentiformis (Torr.) Wats. ssp. breweri (Wats.) Hall and Clem. Brewer's Saltbush. Fig. 56. Shrub; occasional/scattered; berms, roadsides, alluvial fans, sandbars in marsh; Disturbed Coastal Habitat, Coastal Scrub, Irregularly Flooded Estuarine Scrub/Shrub Wetland; 1604, 2060.

Atriplex leucophylla (Moq.) Dietr. Beach Saltbush or Seascale. Prostrate perennial herb; locally extirpated?; edge of salt marsh; R. Hoffman-Hoffman 30 May 1925 (SBM).

Atriplex patula L. ssp. hastata (L.) Hall and Clem. Spear-Leaved Saltbush. Fig. 57. Annual; common/scattered to abundant; berms, dredge spoil, roadsides, alluvial fans, sandbars in marsh, middle to high marshes, ditches, diked marshes; Disturbed Coastal Habitats, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Wetlands; 1721, 1740, 1743, J. Patman 1152 (SBBG), H. Pollard 25 Sep 1956 (CAS).

Atriplex rosea L. Redscale. Fig. 58. Annual; occasional/scattered; berms; Disturbed Coastal Habitat; naturalized; 1608a, 1837, M. Piehl 62446 (SBBG).

Atriplex semibaccata R. Brown. Australian Saltbush. Fig. 59. Prostrate suffrutescent perennial herb or subshrub; common/scattered to common; berms, dredge spoil, roadsides; high marsh; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1607.

Atriplex watsonii A. Nels. Matscale. Fig. 59. Prostrate perennial herb; uncommon to occasional/scattered; banks of berms; sandbars in marsh, high marsh; Irregularly Flooded Estuarine Emergent Wetland; Apple Rd. and sandbar along Sand Point Rd.; 1798, 1858, 1950, R. Hoffmann 2 Nov 1930 (SBM, POM).

Bassia hyssopifolia (Pall.) Kuntze. Hyssop-Leaved Bassia. Fig. 60. Annual; common/scattered to abundant; berms, dredge spoil, roadsides, transitional wetland, vernal depressions; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1594, 1609, 1738.

Beta vulgaris L. ssp. maritima (L.) Arcangeli. Common Beet. Annual or biennial; occasional/scattered to common; berms, roadsides, transitional wetlands, high marsh, diked marshes; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1822, M. Piehl 62437 (SBBG).

Chenopodium berlandieri Moq. Annual; occasional to common/scattered; berms, dredging spoil, roadsides; Disturbed Coastal Habitat; Irregularly Flooded Estuarine Emergent Wetland; 1826, 1844, 2402, 2515, 2517.



FIG. 52. *Nasturtium officinale* R. Br. Watercress. a. Habit. b. Fruit (silique).

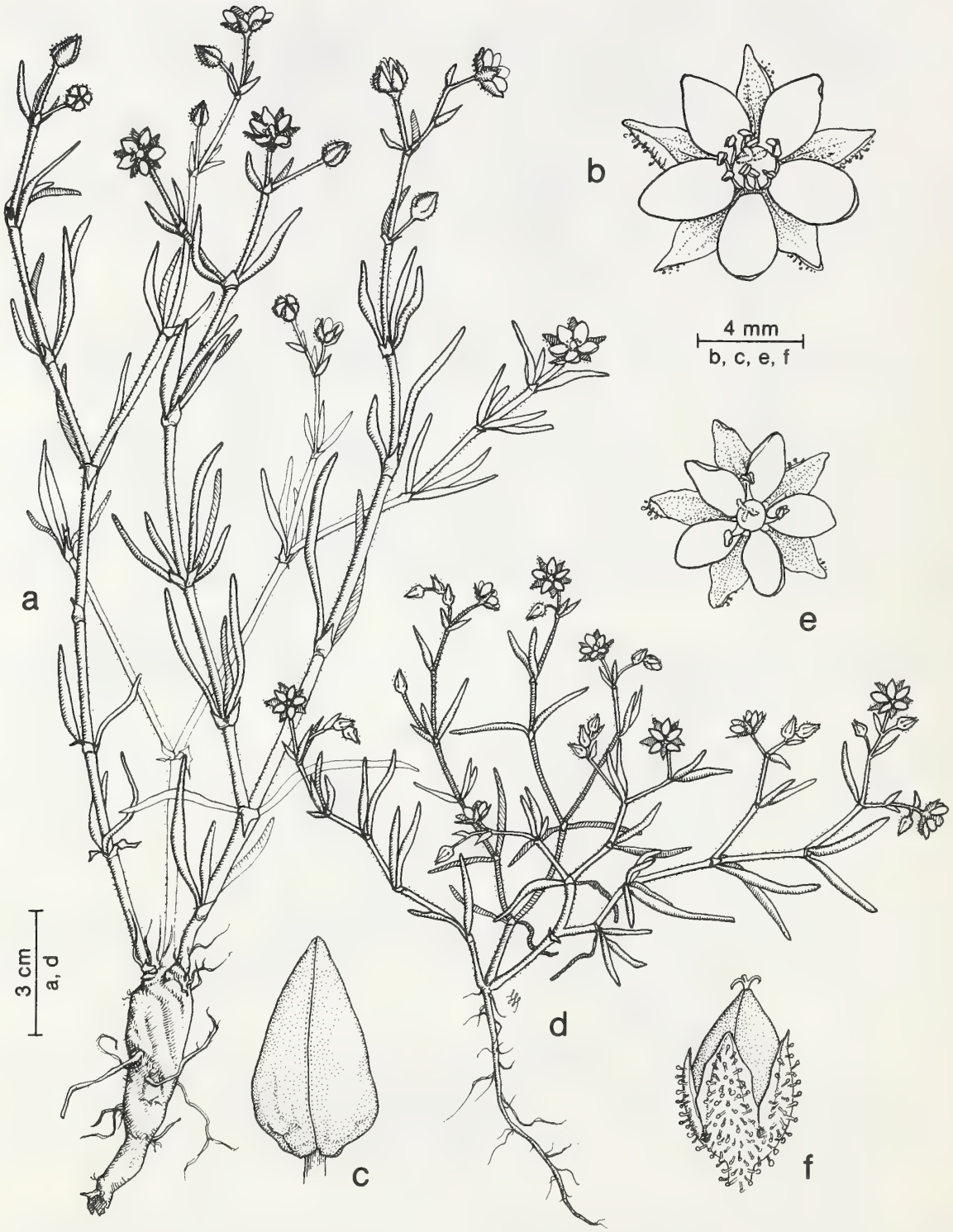


FIG. 53. *Spergularia macrotheca* (Hornem.) Heynh. var. *macrotheca*. Large-Flowered Sand Spurry. a. Habit. b. Flower. c. Capsule. *Spergularia marina* (L.) Griseb. Salt Marsh Sand Spurry. d. Habit. e. Flower. f. Capsule and calyx.

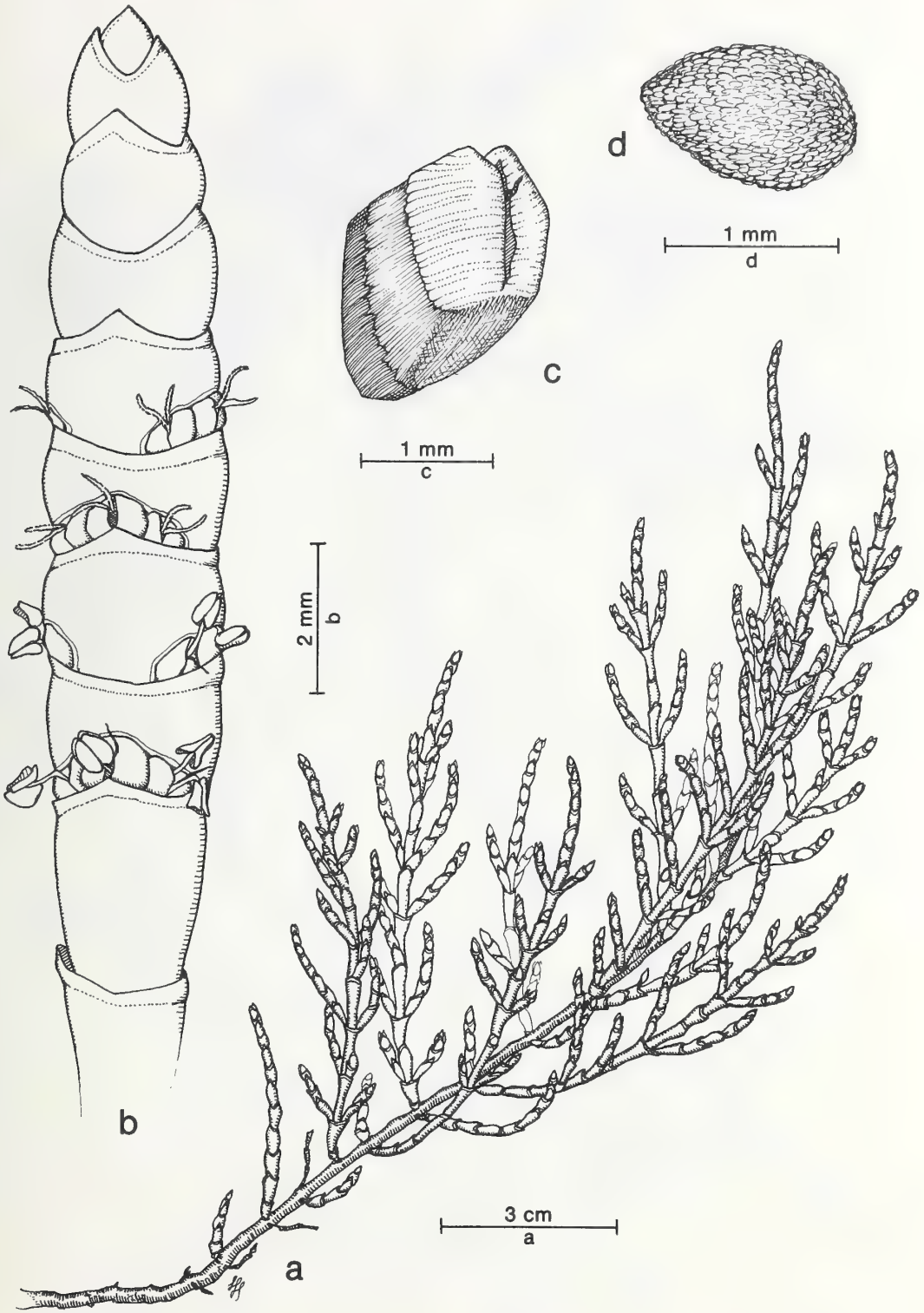


FIG. 54. *Arthrocnemum subterminale* (Parish) Standl. Parish's Glasswort.
a. Habit. b. Inflorescence. c. Flower. d. Seed.

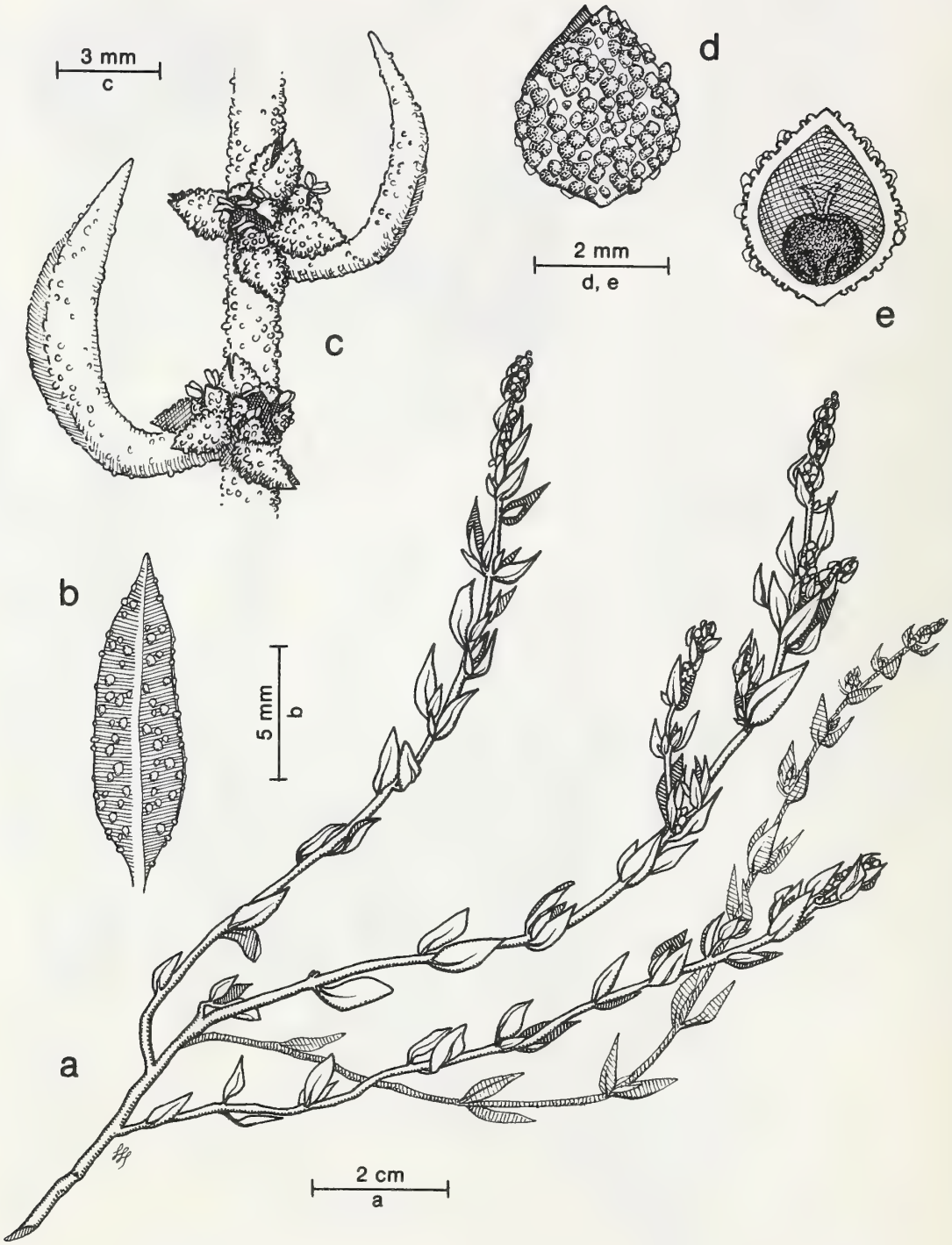


FIG. 55. *Atriplex californica* Moq. in DC. California Saltbush.
a. Decumbent stems, flowering. b. Leaf. c. Flower clusters. d. Bracts of pistillate flower.
e. Pistillate flower.

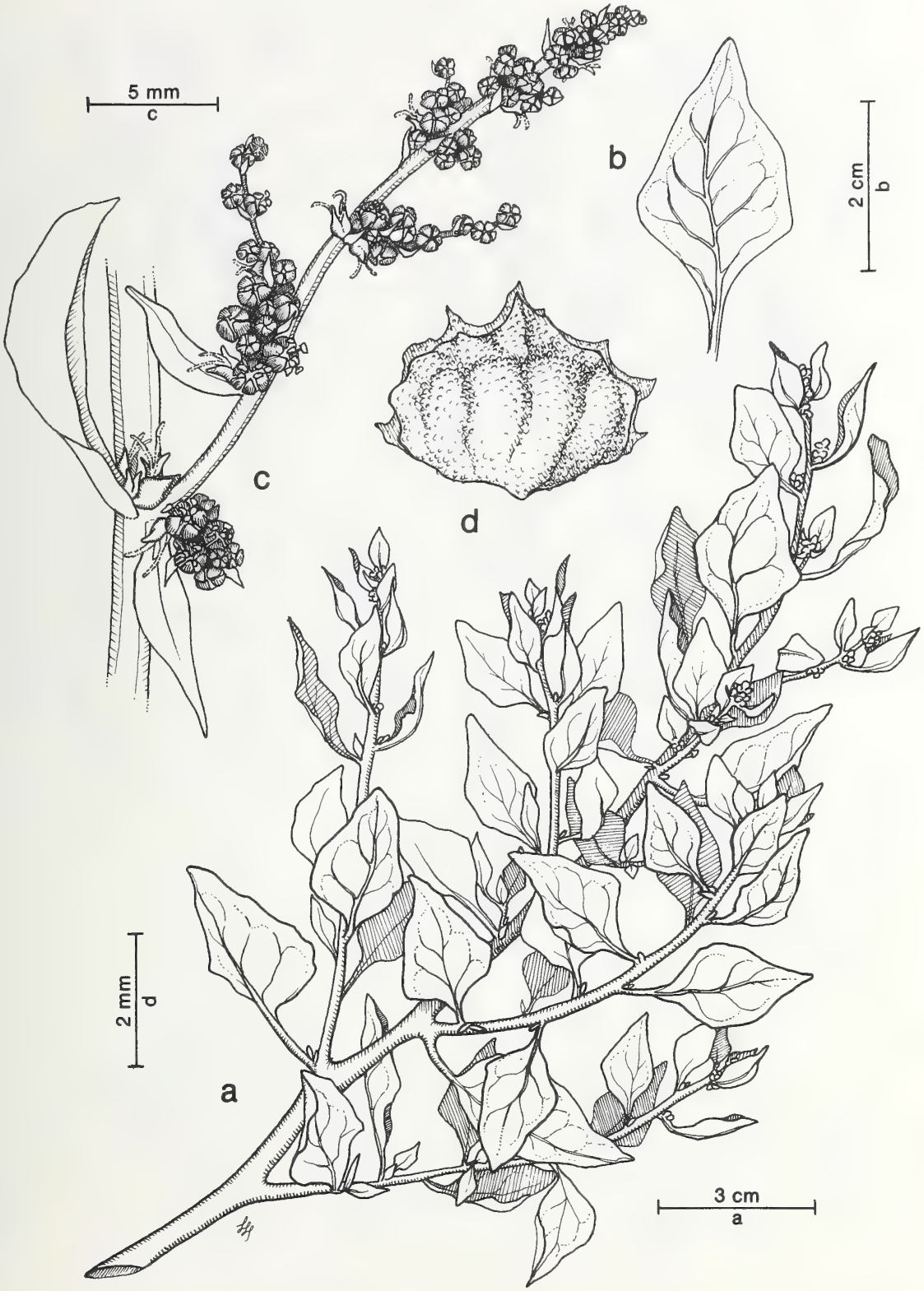


FIG. 56. *Atriplex lentiformis* (Torr.) Wats. ssp. *breweri* (Wats.) Hall and Clem. Brewer's Saltbush. a. Branch. b. Leaf. c. Branch of inflorescence. d. Bracts of pistillate flower.

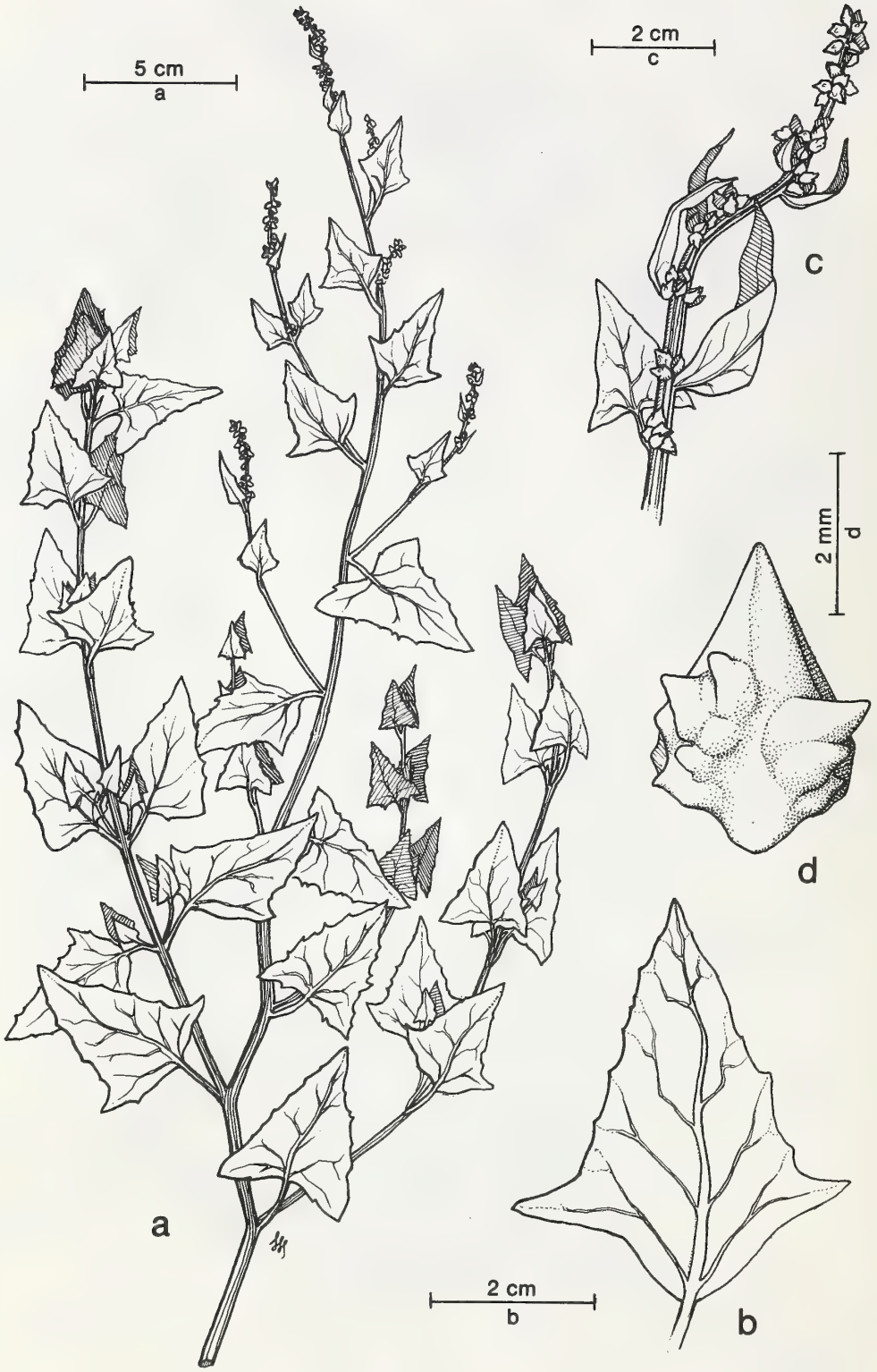


FIG. 57. *Atriplex patula* L. ssp. *hastata* (L.) Hall and Clem. Spear-Leaved Saltbush. a. Upper stem. b. Leaf. c. Branch of inflorescence. d. Bracts of pistillate flower.

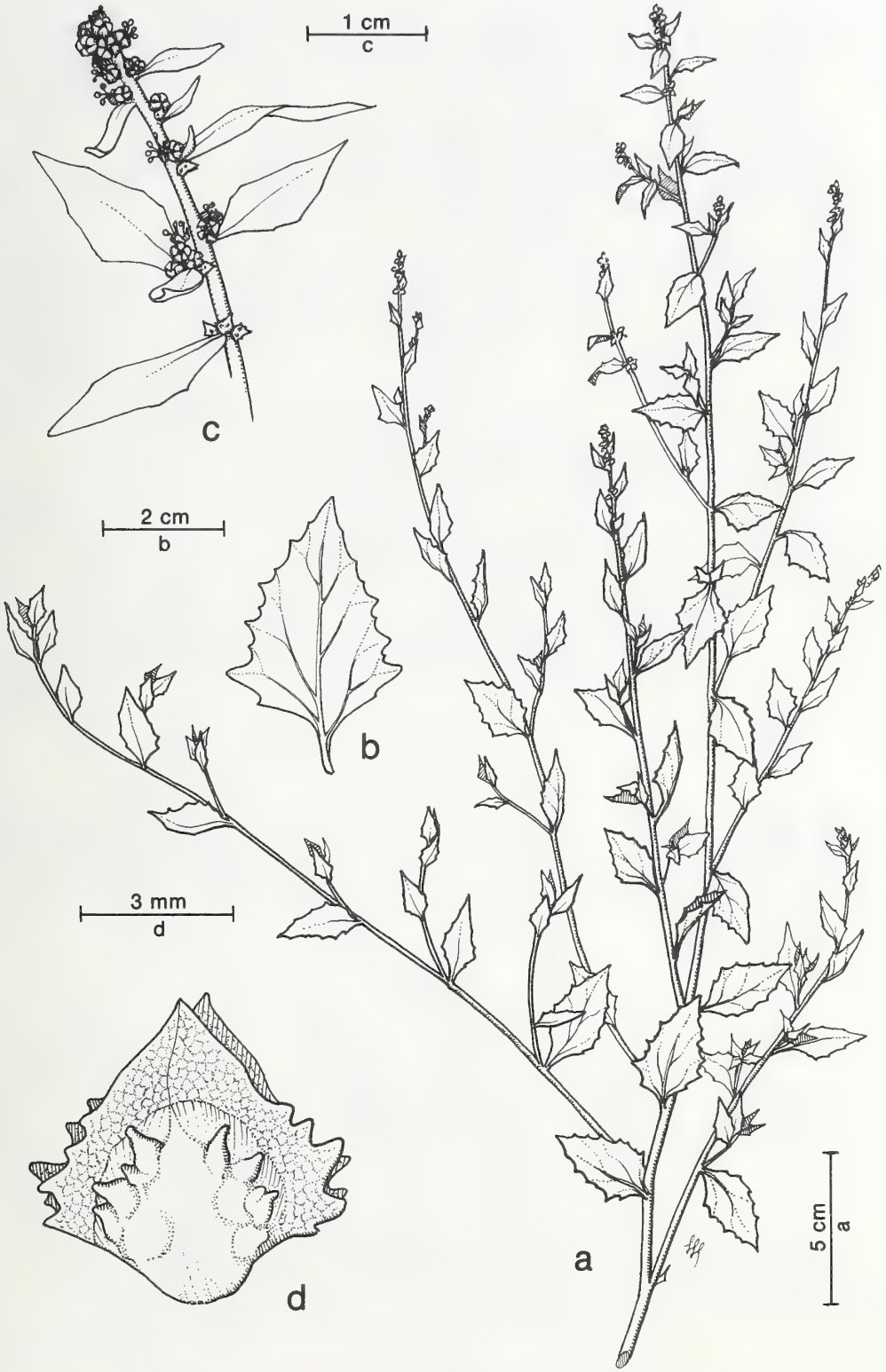


FIG. 58. *Atriplex rosea* L. Redscale.
a. Upper stem. b. Leaf. c. Branch of inflorescence. d. Bracts of pistillate flower.

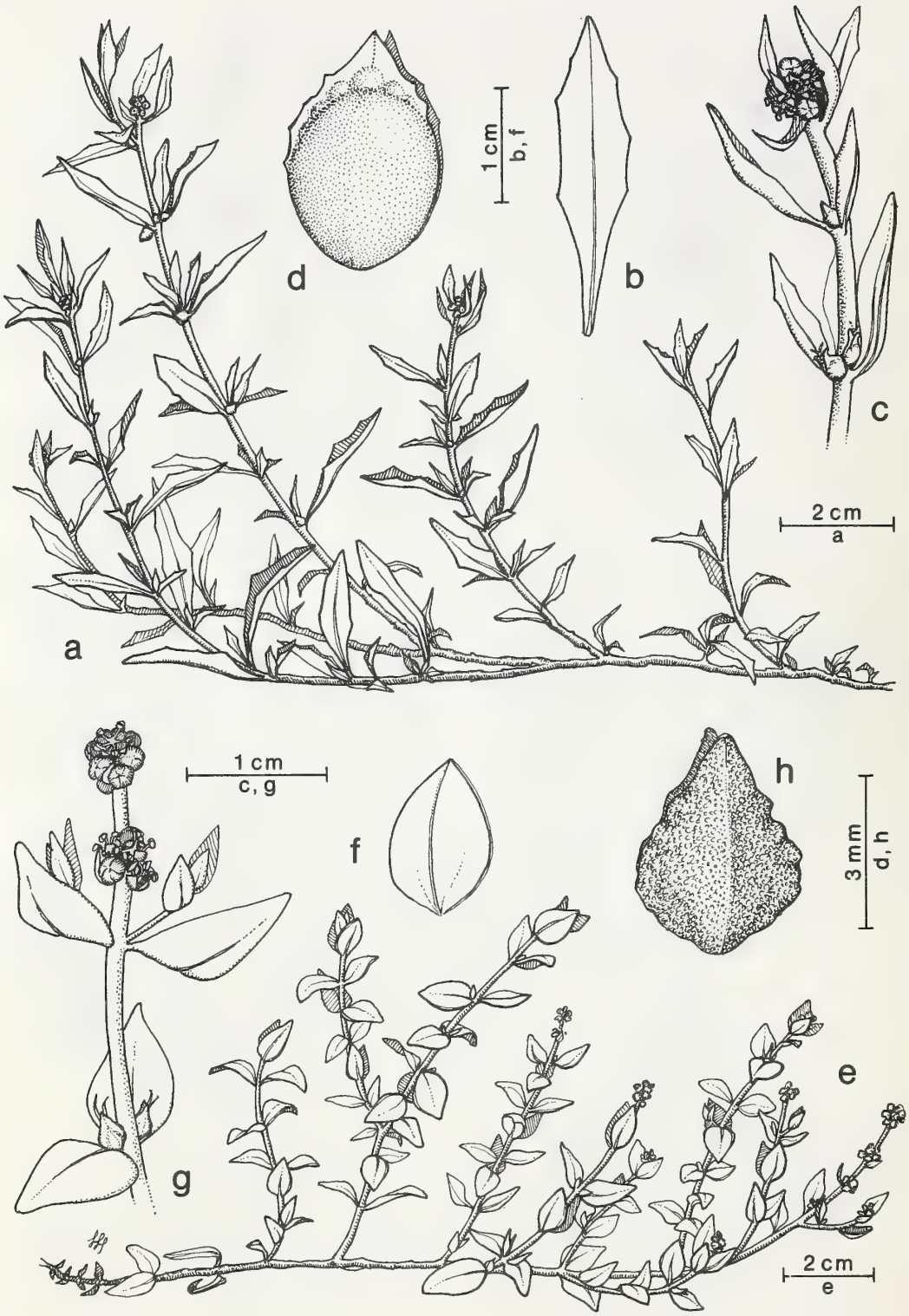


FIG. 59. *Atriplex semibaccata* R. Br. Australian Saltbush.
a. Habit. b. Leaf. c. Branch of inflorescence. d. Bracts of pistillate flower.
Atriplex watsonii A. Nels. Matscale. e. Habit. f. Leaf. g. Branch of inflorescence.
h. Bracts of pistillate flower.

Chenopodium macrospermum Hook. f. var. farinosum (Wats.) J. T. Howell. Coast Goosefoot. Annual; locally extirpated?; drying mudflats and in seepy places about marshes; Carpinteria; H. Pollard 23 Nov 1951, 6 Sep 1952; C. Smith (1976).

Chenopodium murale L. Nettle-Leaved Goosefoot. Annual; uncommon/-scattered; debris pile along ditch near railroad; Disturbed Coastal Habitat; naturalized; 1774, 2750, R. Hoffmann 30 May 1925 (SBM).

Chenopodium strictum Roth. Annual; occasional/scattered; berms, alluvial fans, high marsh; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; H. Pollard 22 Sep 1956, 25 Oct 1957; J. Patman 1153, 1154 (SBBG).

Salicornia virginica L. Pickleweed. Fig. 61. Suffrutescent succulent perennial herb; common/scattered to abundant; berms, dredge spoil, alluvial fans, low, middle and high marshes, transitional wetlands, diked marshes, ditches, vernal depressions; Disturbed Coastal Habitat, Regularly and Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Wetlands; H. Pollard 15 Aug 1955 (CAS) and 1 Aug 1962 (SBBG); F. Embree 280 (UC), M. Piehl 62441 (RSA), R. Thorne and P. Everett 35348 (RSA), J. Patman 1142 (SBBG).

Salsola iberica Sennen and Pau. Russian-Thistle. Fig. 62. Annual; common/scattered to abundant; berms, dredge spoil, roadsides, railroad banks; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1833.

Suaeda calceoliformis (Hook.) Moq. [S. depressa (Pursh) Wats. var. erecta Wats.] Sea-Blite or Seep-Weed. Fig. 63. Annual; occasional/scattered to common; berms, alluvial fans, salt flats, high marsh, vernal depressions; Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; Apple Rd., alluvial fan west of Santa Monica Creek; 1728, 1833, 2071, H. Pollard 21 Sep 1956 (CAS, RSA), and 30 Sep 1957 (UC) and 9 Sep 1964 (SBBG).

Suaeda californica Wats. var. pubescens Jeps. [S. californica var. taxifolia (Standl.) Munz]. Wooly Sea-Blite. Fig. 64. Succulent shrub; uncommon to occasional/scattered; berms, road banks along marsh; Irregularly Flooded Estuarine Emergent and Scrub/Shrub Wetland; Apple Rd. and Sand Point Rd.; 1588, 1805, 2070, H. & M. Dearing 185 (SBBG).

CONVOLVULACEAE Morning-Glory Family

Calystegia macrostegia (Greene) Brummitt ssp. cyclostegia (House) Brummitt. Coast Morning-Glory. Twining perennial herb; occasional/scattered; berms, alluvial fans; Disturbed Coastal Habitat, Coastal Scrub; 1809, 1820.

Convolvulus arvensis L. Bindweed. Twining perennial herb; occasional/scattered; railroad banks; Disturbed Coastal Habitat; naturalized; 1954, H. Pollard 1 Aug 1962 (CAS).

Cressa truxillensis HBK. var. vallicola (Heller) Munz. [C. depressa Goodding]. Alkali Weed. Fig. 65. Perennial herb; uncommon/scattered to common; berms, roadsides, flats; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Wetlands; 1599, 1971.

CUSCUTACEAE Dodder Family

Cuscuta salina Engelm. Salt Marsh Dodder. Fig. 66. Twining parasitic herb; common/scattered to abundant; berms, middle to high marshes and diked marshes; Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; usually parasitic on Salicornia, Frankenia, Distichlis, Jaumea, Arthrocnemum and Atriplex; 1580, 2062, 2146, R. Thorne and P. Everett 35350 (CAS).

EUPHORBIACEAE Spurge Family

Euphorbia lathyrus L. Caper Spurge. Annual or biennial; uncommon/scattered; margin of marsh along railroad; Palustrine Forested Wetland; naturalized; 1789, 2405b.

Euphorbia peplus L. Petty Spurge. Annual; occasional/scattered; low berm adjacent to ditch along railroad; Disturbed Coastal Habitat, Palustrine Emergent Wetland; naturalized; 1775.

Ricinus communis L. Castor-Bean. Shrub; occasional/scattered; berms, depressions, alluvial fans, roadsides, railroad banks, debris piles, alluvial fans; Disturbed Coastal Habitat; naturalized; 2315b.

FABACEAE Pea Family

Lotus corniculatus L. Bird's-Foot Trefoil. Perennial herb; rare/common; roadside margin of marsh; Disturbed Coastal Habitat; Sand Point Rd.; naturalized; 2746.

Lotus salsuginosus Greene ssp. salsuginosus. Coastal Hosackia. Prostrate annual; occasional/ scattered; berms, dredge spoil; Disturbed Coastal Habitat; 1802, 2395.

Lotus scoparius (Nutt.) Ottley ssp. scoparius. Deerweed. Subshrub; uncommon to occasional/scattered; berms; Disturbed Coastal Habitat, Coastal Scrub; 1800.

Lupinus succulentus Dougl. ex Koch ssp. succulentus. Succulent Lupine. Annual; occasional/scattered to common; berms, roadsides; Disturbed Coastal Habitat; 1823, 1937, 2065, 2200.

Medicago polymorpha L. Bur Clover. Prostrate annual; common/scattered to common; berms, dredge spoil, roadsides, debris piles, alluvial fans, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1761.

Melilotus alba Medic. White Sweet-Clover. Annual; occasional/scattered to abundant; berms, dredge spoil, debris piles, alluvial fans; Disturbed Coastal Habitat; naturalized; 1818.

Melilotus indica (L.) All. Indian Sweet-Clover. Annual; common/scattered to abundant; berms, dredge spoil, roadsides, debris piles, alluvial fans, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1769, 2197, 2207.

Psoralea orbicularis Lindl. Round-Leaved Psoralea. Perennial herb; locally extirpated?; highway near salt marsh; Palustrine Emergent Wetland?; H. Pollard 22 Jun 1955 (CAS); C. Smith (1976).

Trifolium ciliolatum Benth. Tree Clover. Annual; uncommon/scattered; berms, dredge spoil; Disturbed Coastal Habitat; 2399.

Vicia sativa L. Common Vetch. Annual; occasional/scattered; roadsides, margin of marsh along railroad; Disturbed Coastal Habitat, Palustrine Forested Wetland; naturalized; 1940, 1958.

FRANKENIACEAE Frankenia Family

Frankenia grandifolia Cham. and Schlecht. var. grandifolia [F. salina (Mol.) I. M. Johnst.]. Alkali Heath. Fig. 67. Suffrutescent perennial herb or subshrub; common/scattered to common; berms, alluvial fans, sandbars in marsh, middle to high marshes, transitional wetlands, diked marshes, ditches; Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; 1947, UCSB Bot. Soc. 27, H. Pollard 21 Sep 1956 (CAS), D. Breedlove 4039 (CAS).

GERANIACEAE Geranium Family

Erodium moschatum (L.) L'Her. Whitestem Filaree. Annual; uncommon/scattered; debris piles; Disturbed Coastal Habitat; naturalized; 1971.

GROSSULARIACEAE Gooseberry Family

Ribes amarum McClatchie var. hoffmannii Munz. Bitter Gooseberry. Shrub; rare/rare; alluvial fan debris pile; Disturbed Coastal Habitat; naturalized; 2318.

Ribes menziesii Pursh var. hystrix (Eastw.) Jepson. Bristly or Porcupine Gooseberry. Shrub; rare/scattered; margin of marsh along railroad; Disturbed Coastal Habitat, Palustrine Forested Wetland; naturalized?; 1791, 2308.

HYDROPHYLLACEAE Waterleaf Family

Eucrypta chrysanthemifolia (Benth.) Greene var. chrysanthemifolia. Common Eucrypta. Annual; uncommon/common; alluvial fan, transitional wetland; Irregularly Flooded Estuarine Emergent Wetland; 1838.

Phacelia distans Benth. Wild Heliotrope. Annual; occasional/common; sandy roadside; Disturbed Coastal Habitat; Sand Point Rd.; 1941.

Phacelia ramosissima Dougl. ex Lehm. var. suffrutescens Parry. [P. r. var. austrolitoralis Munz]. Branching Phacelia. Shrub; uncommon to occasional/scattered; berms, alluvial fans, debris piles; Disturbed Coastal Habitat, Coastal Scrub; 2321.

LAMIACEAE Mint Family

Lamium amplexicaule L. Giraffe Head. Annual; uncommon/common; berms; Disturbed Coastal Habitat; naturalized; 2754.

Mentha spicata L. Spearmint. Perennial; occasional/scattered?; Franklin Creek at railroad crossing; naturalized; H. Pollard 21 Oct 1958 (CAS).

Stachys bullata Benth. Wood Mint or California Hedge Nettle. Perennial herb; uncommon/scattered to common; berms, margin of marsh along railroad; Coastal Scrub, Palustrine Forested Wetland; 1784.

Stachys rigida Nutt. ssp. quercetorum (Heller) Epling. Rigid Hedge Nettle. Perennial herb; locally extirpated?; marsh along railroad and Santa Monica Creek; H. Pollard 26 Aug 1956 (CF), 22 Aug 1957 (CAS), 24 Nov 1958 (CF).

MALVACEAE Mallow Family

Lavatera cretica L. Cretan Lavatera. Annual; occasional/scattered to common; berms, dredge spoil, roadsides, alluvial fans; Disturbed Coastal Habitat; naturalized; 1806, 1984.

Malacothamnus fasciculatus (Nutt. ex T. & G.) Greene var. nuttallii (Abrams) kearn. Chaparral Mallow. Shrub; occasional/scattered; berms, alluvial fans, debris piles; Disturbed Coastal Habitat, Coastal Scrub; 2320, H. Pollard 26 Aug 1958 (CAS), D. Breedlove 4034 (CAS).

Malva nicaeensis All. Bull Mallow. Annual; occasional/scattered; berms, dredge spoil; Disturbed Coastal Habitat; naturalized; 2202, 2205.

Malva parviflora L. Cheese-Weed. Annual; common/scattered to common; berms, dredge spoil, roadsides, debris piles, alluvial fans, transitional wetlands; Disturbed Coastal Habitat; Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1803, 2203, 2396.

Malvella leprosa (Ort.) Krapov. [Sida leprosa (Ort.) K. Schum. var. hederacea (Dougl.) K. Schum.]. Alkali Mallow. Perennial herb; uncommon/scattered to common; berms, banks; Disturbed Coastal Habitat; 2311, M. Piehl 63771 (SBBG).

MIMOSACEAE Mimosa Family

Acacia longifolia (Andr.) Willd. Golden Wattle. Shrub; rare/rare; berm; Disturbed Coastal Habitat; naturalized; 1855.

MYOPORACEAE Myoporum Family

Myoporum laetum Forst. f. Myoporum. Shrub or small tree; occasional to common/scattered to abundant; berms, alluvial fans, high marsh; cultivated and Disturbed Coastal Habitat or Irregularly Flooded Estuarine Emergent Wetland; introduced and persistent or naturalized; 1795, H. Pollard 15 Aug 1955 and 9 Sep 1964 (CAS).

NYCTAGINACEAE Four O'Clock Family

Abronia umbellata Lam. ssp. umbellata. Sand-Verbena. Prostrate succulent perennial; rare/rare; dune, dredge spoil; Partially Stabilized and Stabilized Dunes, Disturbed Coastal Habitat; 2079, 2107, J. Patman 1123 (SBBG).

ONAGRACEAE Evening Primrose Family

Camissonia cheiranthifolia (Hornem. ex Spreng.) Raimann in Engl. & Prantl. ssp. suffruticosa (Wats.) Raven. Beach Primrose. Fig. 68. Suffrutescent perennial herb; occasional/scattered to common; dunes, sandy roadsides, berms; Partially Stabilized and Stabilized Dune, Disturbed Coastal Habitat; Sand Point Rd.; 1860, 1869, J. Patman 1149 (SBBG).

Epilobium ciliatum Raf. ssp. ciliatum. [E. adenocaulon Hausskn.]. Northern Willow-Herb. Perennial herb; occasional/scattered; ditches, margin of marsh along railroad, stream banks; Palustrine Emergent, Scrub/Shrub, and Forested Wetlands; Carpinteria Salt Marsh and Creek; 2143, H. Pollard 25 Sep 1956, 15 Jul 1957, 4 Sep 1958 (CF).

OXALIDACEAE Wood-Sorrel Family

Oxalis pes-caprae L. Sour Grass. Perennial herb; uncommon/scattered; berms, debris piles, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1757.

PITTOSPORACEAE Pittosporum Family

Pittosporum undulatum Vent. Victorian Box. Shrub or tree; rare/scattered; margin of marsh along railroad; Palustrine Forested Wetland; naturalized; 2361.

PLANTAGINACEAE Plantain Family

Plantago lanceolata L. Ribgrass or English Plantain. Perennial herb; occasional/scattered; berms, roadsides, debris piles; Disturbed Coastal Habitat; naturalized; 1979.

PLUMBAGINACEAE Leadwort Family

Limonium californicum (Boiss.) Heller. California Sea Lavender or Marsh Rosemary. Fig. 69. Perennial herb; occasional to common/scattered to common; berms, alluvial fans, middle and high marshes, transitional wetlands; Irregularly Flooded Estuarine Wetland; 1582a, 2063, H. Pollard 6 Sep 1952 (CAS), D. Breedlove 4040 (CAS), J. Patman 1141 (SBBG).

Limonium sinuatum (L.) P. Mill. Sea-Lavender. Perennial herb; rare/rare; bank of berm; Irregularly Flooded Estuarine Emergent Wetland; Apple Rd.; naturalized; 2747.

POLYGONACEAE Buckwheat Family

Eriogonum fasciculatum Benth. ssp. foliolosum (Nutt.) Stokes. California Buckwheat. Shrub; rare/rare; low ground along railroad; Disturbed Coastal Habitat; H. Pollard 19 Sep 1964 (CAS).

Polygonum arenastrum Jord. ex Boreau. Common Knotweed. Prostrate annual; occasional/scattered; berms, debris piles; Disturbed Coastal Habitat; naturalized; 2130.

Polygonum aviculare L. Common Knotweed. Prostrate annual; occasional/scattered; railroad bank, ditches; Disturbed Coastal Habitat, Seasonally Flooded Palustrine Emergent Wetland; naturalized; 1782, H. Pollard 22 Aug 1957 (CF).

Polygonum punctatum Ell. var. confertiflorum (Meisn.) Fassett [P. p. var. leptostachyum (Meisn.) Small]. Dotted Smartweed. Perennial herb; occasional/scattered to common; ditches; margin of marsh along railroad; Palustrine Emergent and Forested Wetlands; 2141, UCSB Bot. Soc. 31.

Rumex acetocella L. Sheep Sorrel. Perennial herb; rare/rare; Meyers (1974).

Rumex conglomeratus Murr. Green or Clustered Dock. Perennial herb; uncommon/scattered; margin of marsh along railroad; Palustrine Forested Wetland; naturalized; 1956, 2263.

Rumex crassus Rech f. Perennial herb; locally extirpated?; marsh; Palustrine Emergent Wetland?; C. Smith (1976).

Rumex crispus L. Curly Dock. Perennial herb; occasional to common/scattered; berms, roadsides, alluvial fans, transitional wetlands, ditches; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Wetlands; naturalized; 1779a.

Rumex obtusifolius L. ssp. agrestis (Fries) Danser. Bitter Dock. Perennial herb; uncommon/scattered?; margin of marsh and along creek; Palustrine Emergent Wetland; Santa Monica Creek; naturalized; H. Pollard 30 Sep 1957, 20 Jun 1958 (CAS), 31 Aug 1961 (SBBG).

Rumex salicifolius Weinm. Willow Dock. Perennial herb; uncommon/scattered; margin of marsh adjacent to railroad; Palustrine Forested Wetland; Carpinteria Salt Marsh and Creek; H. Pollard 19 Jul 1957, 1 Aug 1962 (CAS).

PRIMULACEAE Primrose Family

Anagallis arvensis L. var. arvensis. Pimpernel. Annual; occasional/scattered to common; berms, dredge spoil, ditches; Disturbed Coastal

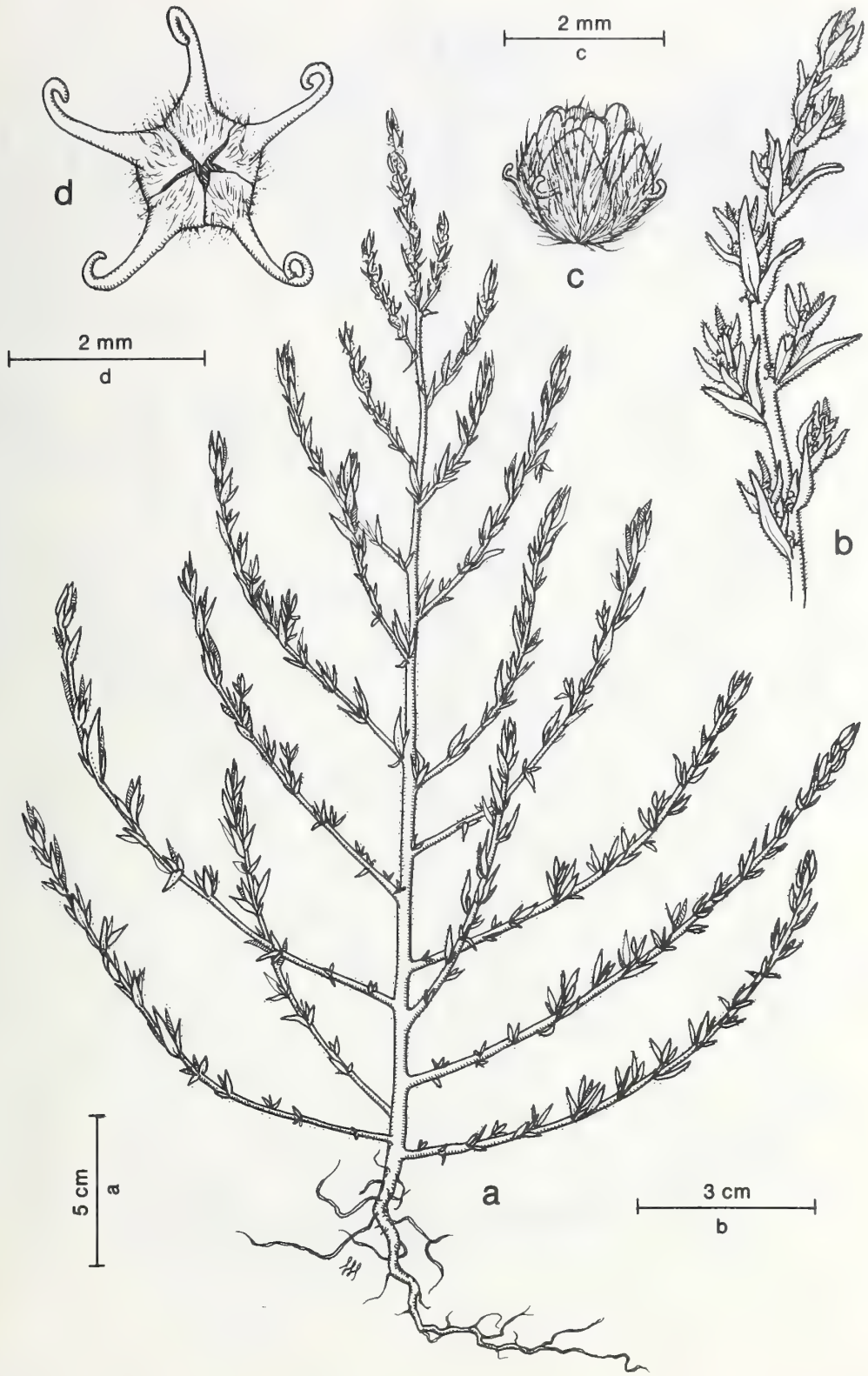


FIG. 60. *Bassia hyssopifolia* (Pall.) Kuntze. Hyssop-Leaved Bassia.
a. Habit. b. Branch of inflorescence. c. Flower. d. Mature calyx with hooked spines.

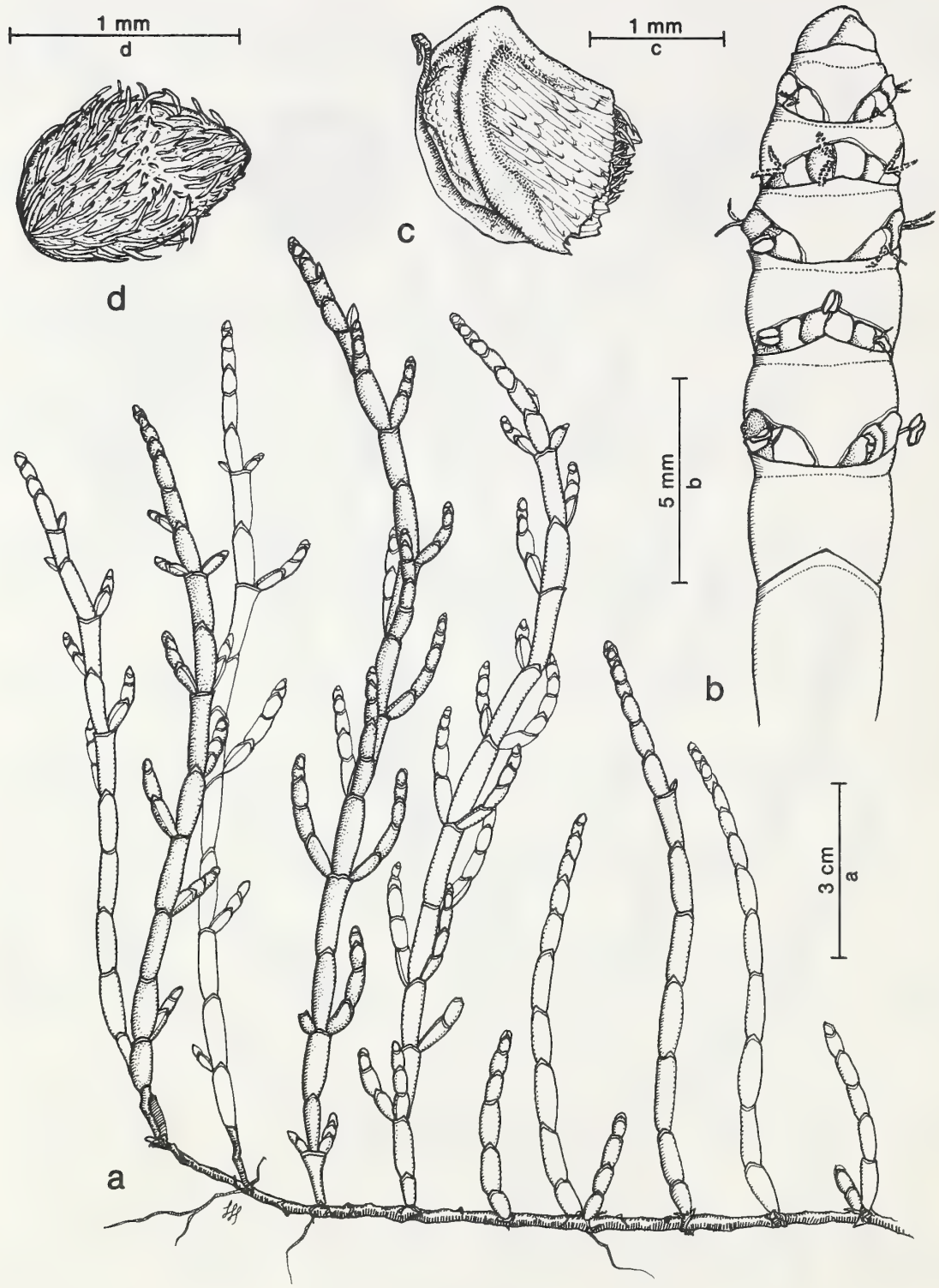


FIG. 61. *Salicornia virginica* L. Pickleweed.
a. Habit. b. Inflorescence. c. Flower with ripening ovary. d. Seed.

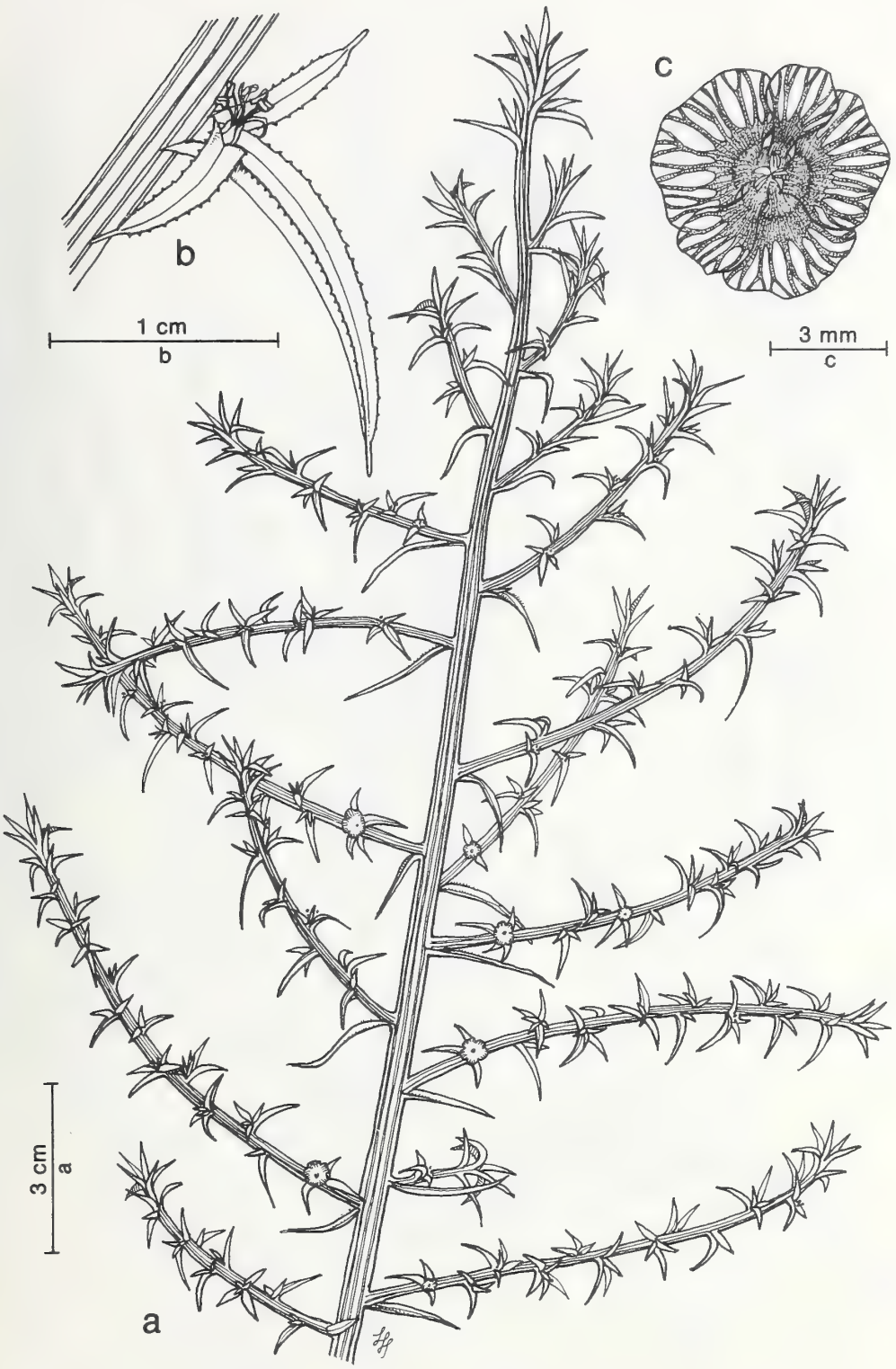


FIG. 62. *Salsola iberica* Sennen and Pau. Russian Thistle.
a. Branch. b. Flower and bracts. c. Winged calyx of fruit.

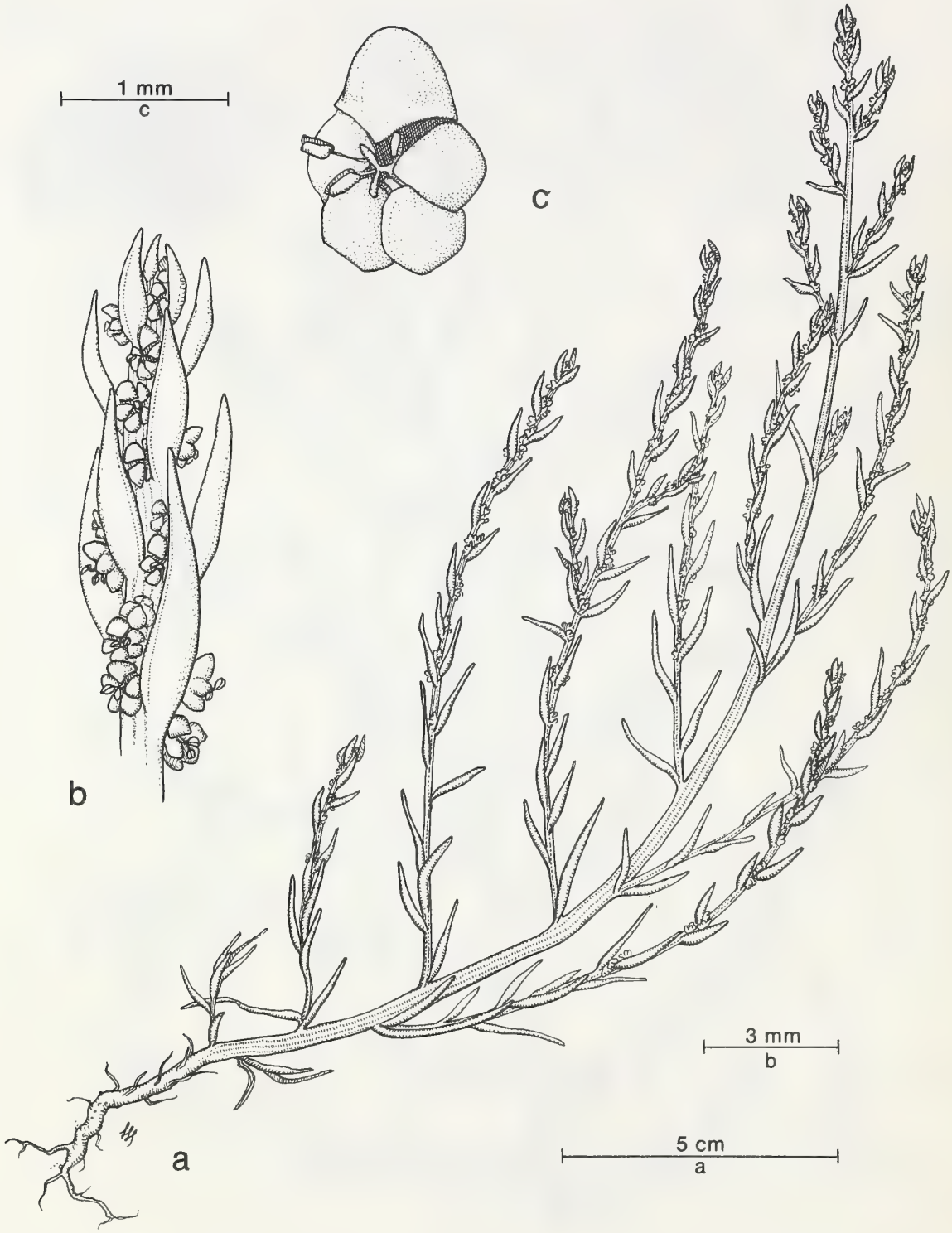


FIG. 63. *Suaeda calceoliformis* (Hook.) Moq. Sea-Blite, Seep-Weed.
a. Habit. b. Inflorescence. c. Flower.

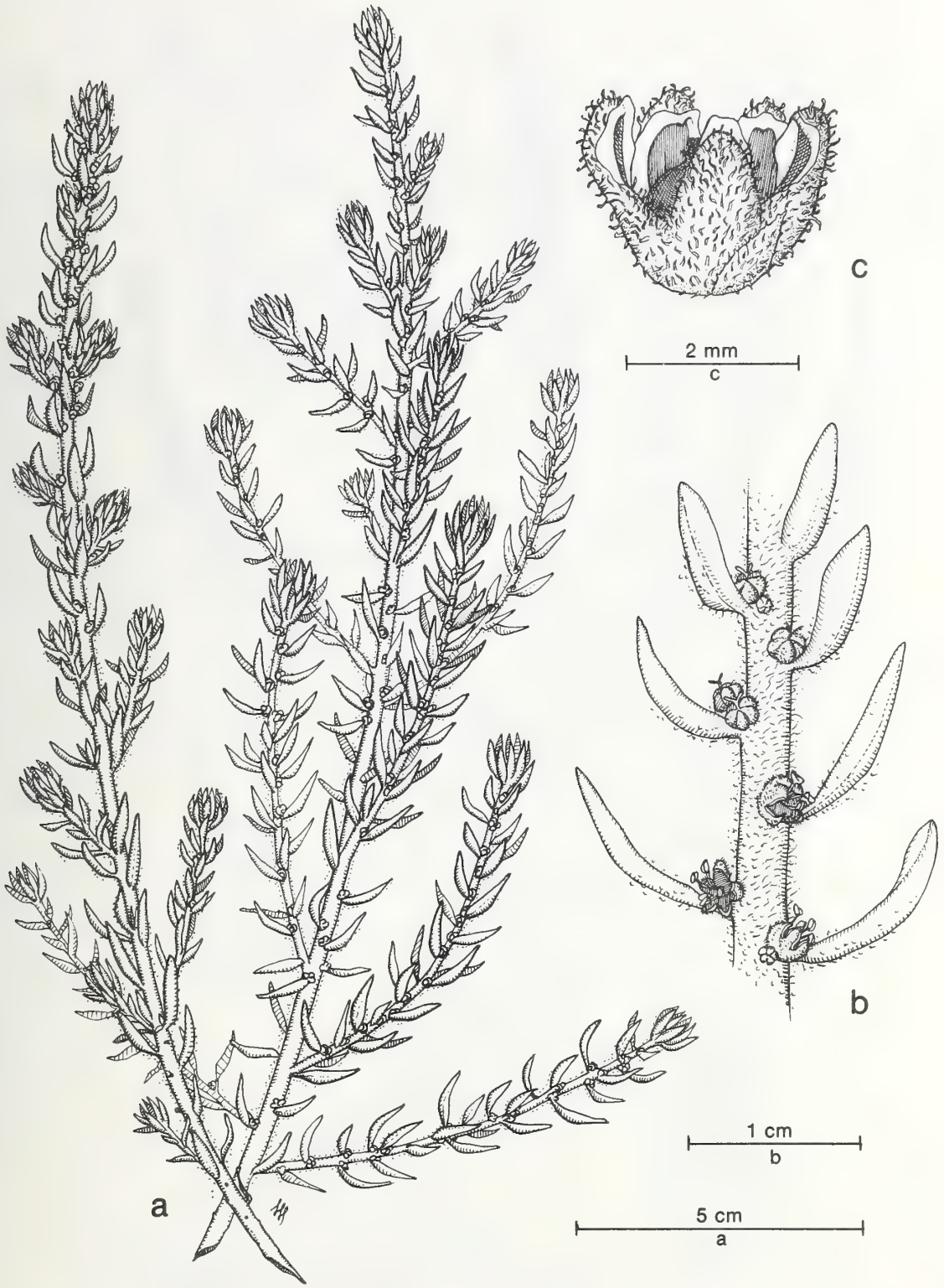


FIG. 64. *Suaeda californica* Wats. var. *pubescens* Jeps. Wooly Sea-Blite.
a. Branches. b. Segment of inflorescence. c. Calyx with ripening ovary.

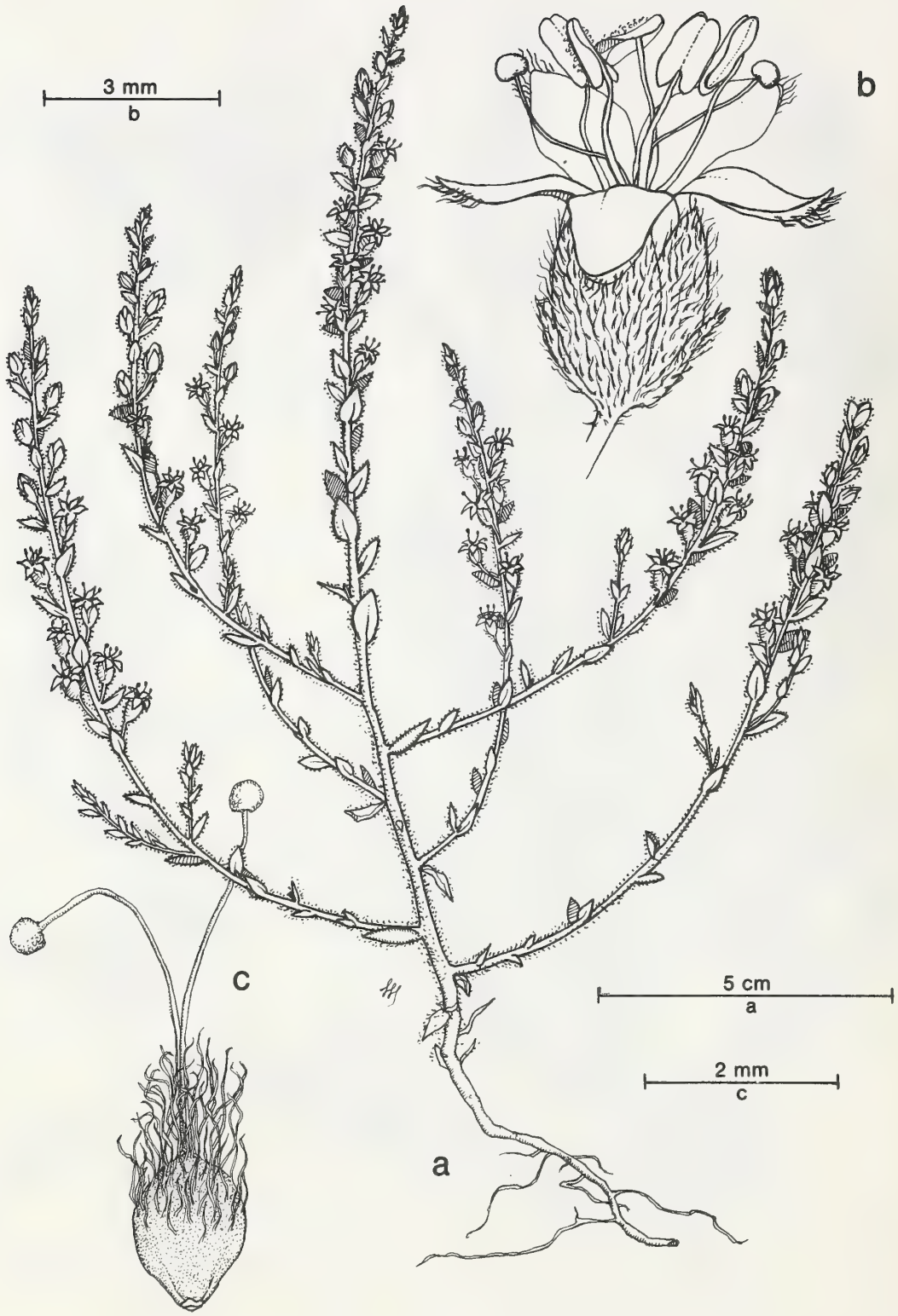


FIG. 65. *Cressa truxillensis* HBK. var. *vallicola* (Heller) Munz. Alkali Weed.
a. Habit. b. Flower. c. Ripening ovary.

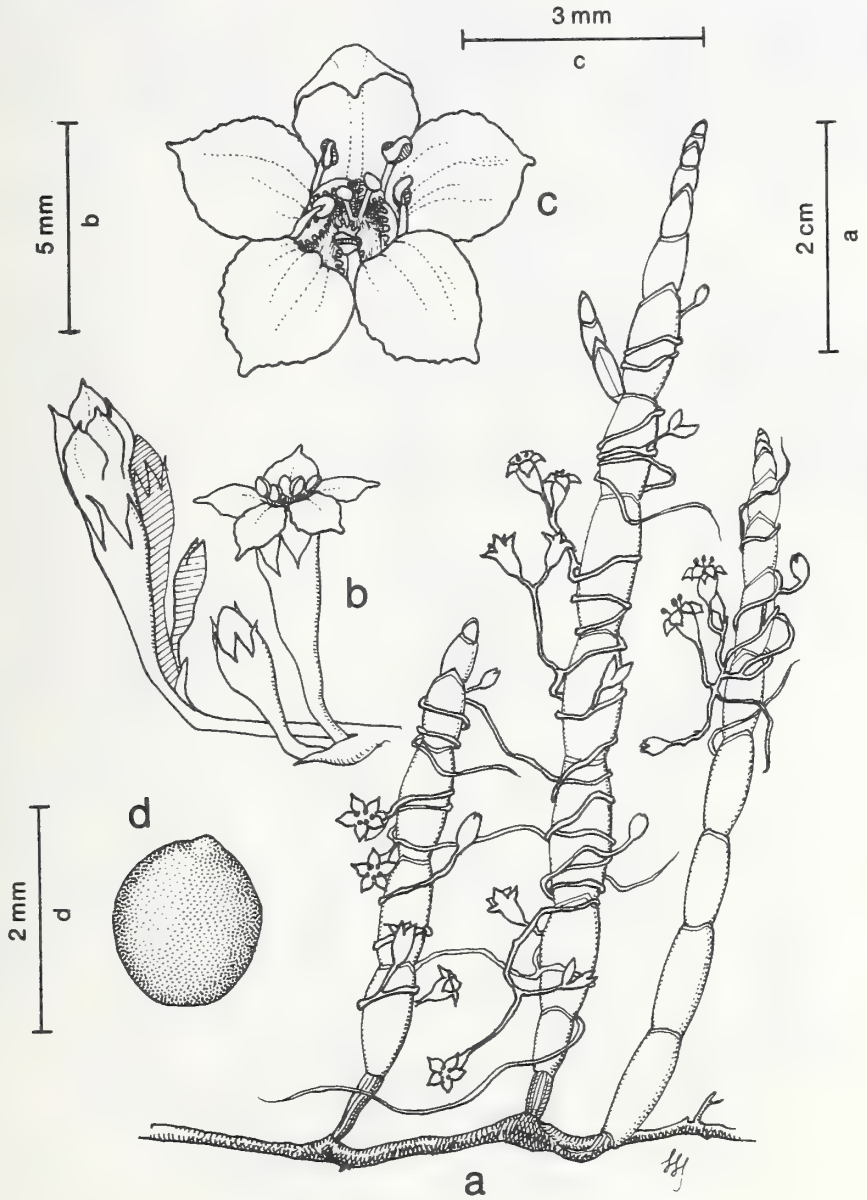


FIG. 66. *Cuscuta salina* Engelm. Salt Marsh Dodder.
a. Parasitic on *Salicornia virginica*. b. Inflorescence. c. Flower. d. Seed.

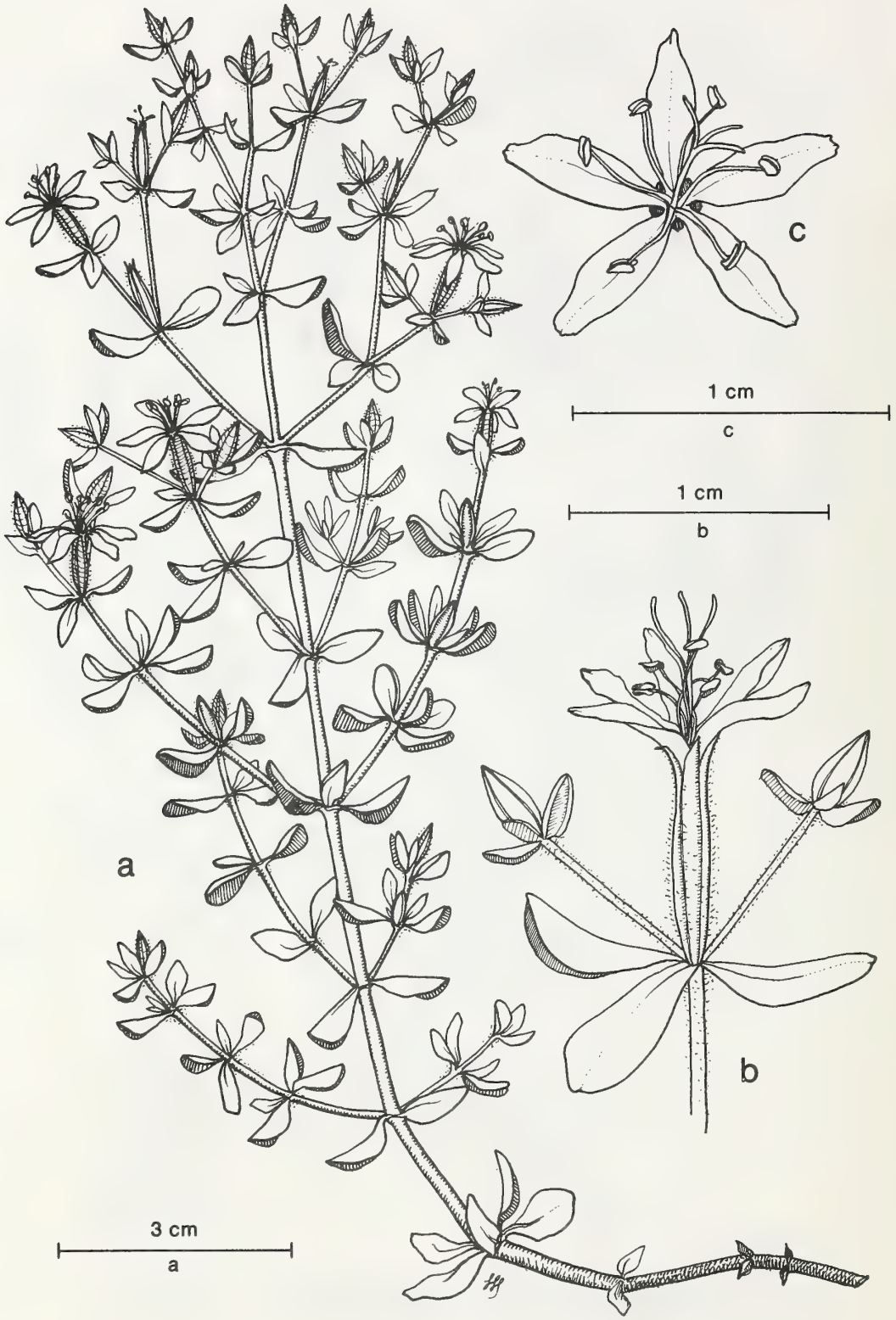


FIG. 67. *Frankenia grandifolia* Cham. and Schlecht. var. *grandifolia*. Alkali Heath. a. Habit. b. Portion of inflorescence. c. Flower.

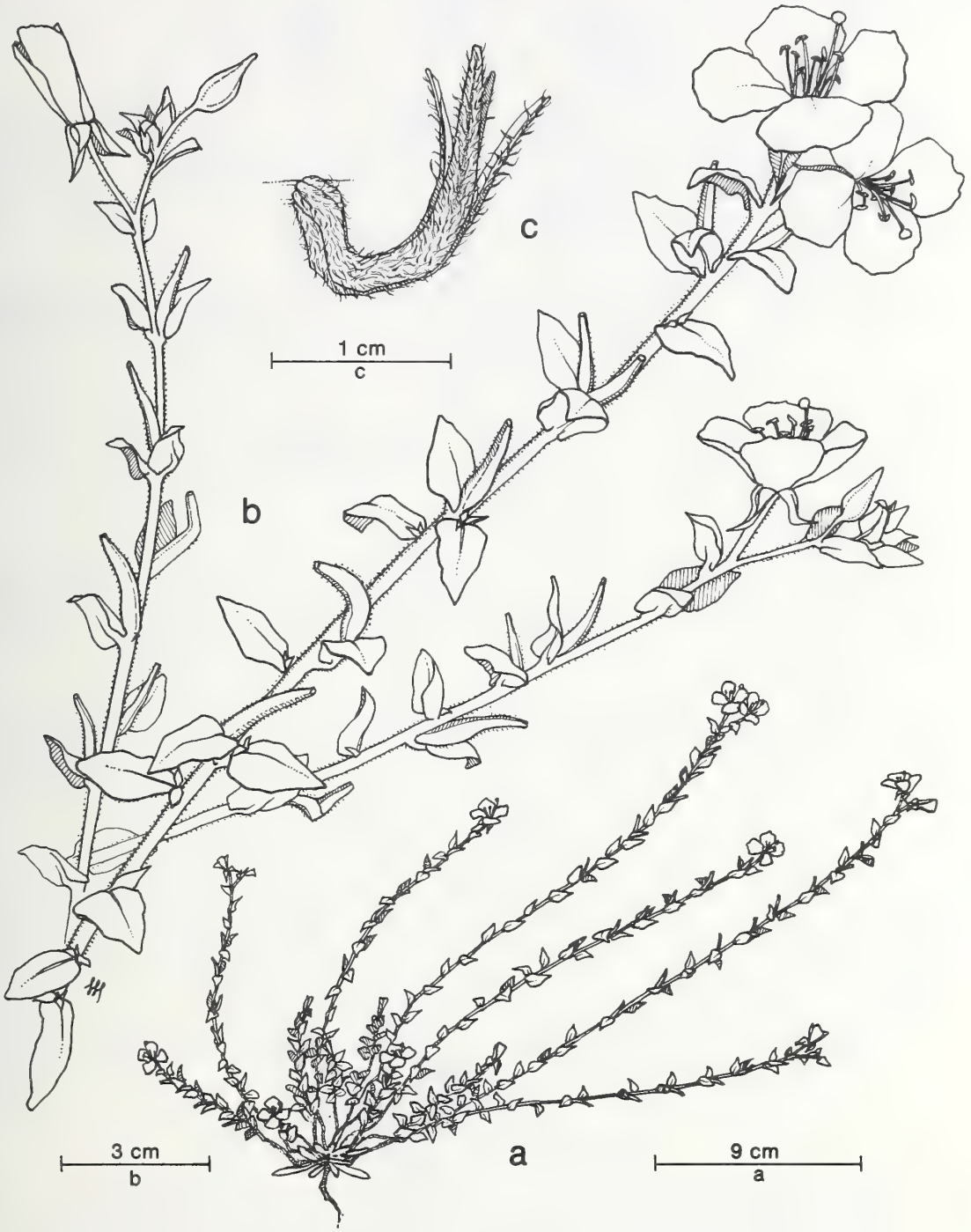


FIG. 68. *Camissonia cheiranthifolia* (Hornem. ex Spreng.) Raimann in Engl. and Prantl ssp. *suffruticosa* (Wats.) Raven. Beach Primrose. a. Habit. b. Inflorescence. c. Capsule.

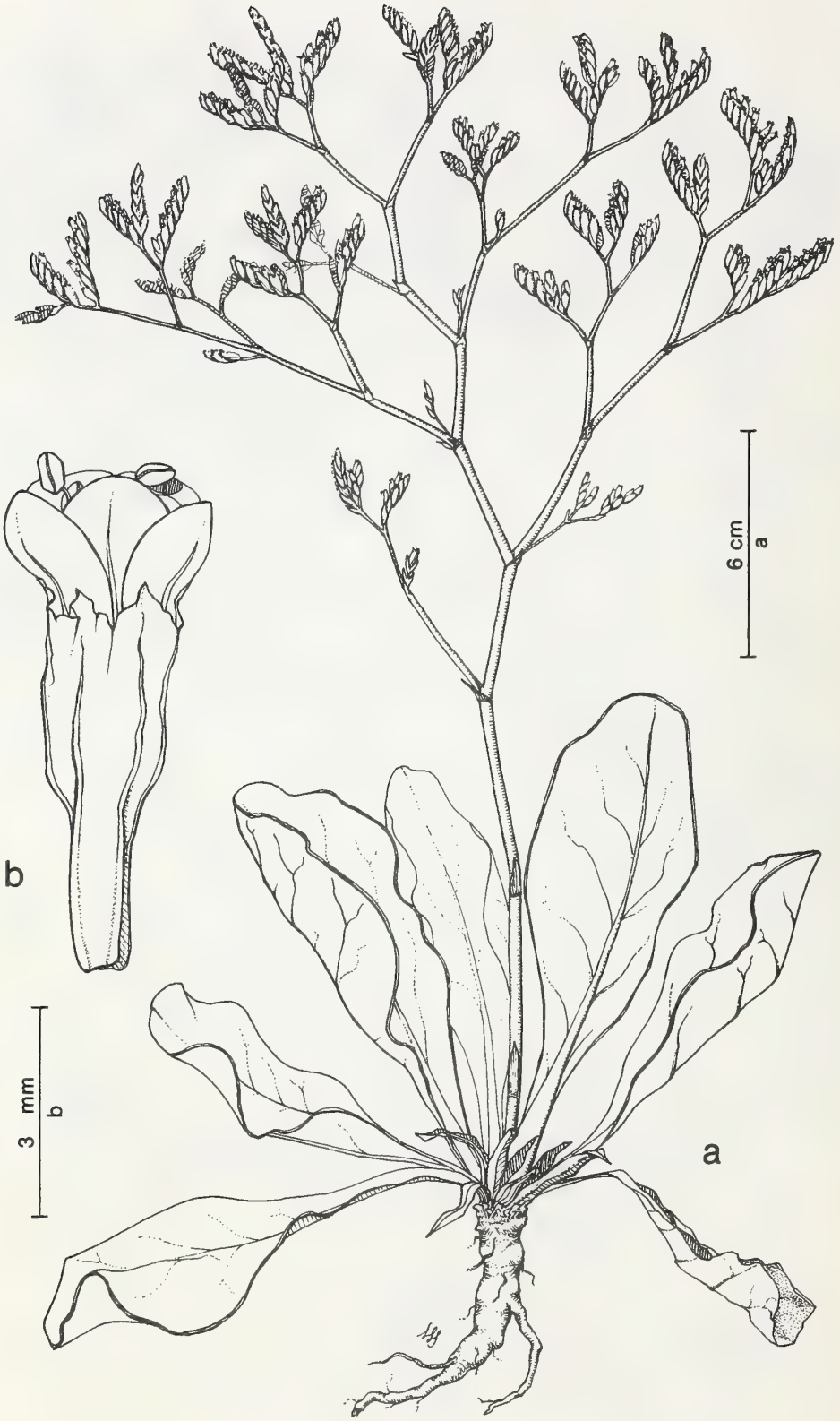


FIG. 69. *Limonium californicum* (Boiss.) Heller. California Sea-Lavender.
a. Habit. b. Flower.

Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1781, H. Pollard 1 Aug 1962 (CAS).

RANUNCULACEAE Crowfoot Family

Clematis lasiantha Nutt. in T. & G. Chaparral Clematis. Woody vine; rare/rare; roadside; Disturbed Coastal Habitat; associated with persistent cultivated shrubs?; 2543.

RHAMNACEAE Buckthorn Family

Ceanothus megacarpus Nutt. ssp. megacarpus. Bigpod Ceanothus. Shrub; rare/scattered; berms, roadsides; Disturbed Coastal Habitat; vicinity of Sandyland Cove Rd.; persisting after cultivation?; 2544a.

Ceanothus spinosus Nutt. in T. & G. Greenbark. Shrub; rare/scattered; berms, roadsides; Disturbed Coastal Habitat; vicinity of Sandyland Cove Rd., persisting after cultivation?; 2542.

ROSACEAE Rose Family

Potentilla anserina L. ssp. pacifica (T. J. Howell) Rousi [P. egedei Wormsk. var. grandis (Rydb.) J. T. Howell]. Pacific Silverweed. Perennial; locally extirpated?; mouth of Carpinteria Creek; H. Pollard 21 Aug 1955 (CAS).

Rubus ursinus Cham. and Schlecht. California Blackberry. Trailing shrub; occasional/scattered; margin of marsh along railroad; Palustrine Forested Wetland; 1788.

RUBIACEAE Madder Family

Galium aparine L. Cleavers or Goose Grass. Annual; occasional/common; berms, alluvial fans, transitional wetland; Diisturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1825, 2210, 2393, J. Patman 1138 (SBBG).

Galium parisiense L. Wall Bedstraw. Annual; uncommon/?; Disturbed Coastal Habitat; east end of estuary; naturalized; M. Piehl 62433 (SBBG).

SALICACEAE Willow Family

Salix exigua Nutt. Narrowleaf Willow. Shrub; locally extirpated?; mouth of stream; Disturbed Coastal Habitat, Palustrine Scrub/Shrub Wetland; Carpinteria Creek; H. Pollard 7 Mar 1959 (CF).

Salix laevigata Bebb. Red Willow. Tree; locally extirpated?; along streams and edge of marsh; Palustrine Forested Wetland; Santa Monica and Carpinteria Creeks and Carpinteria Salt Marsh; H. Pollard 7 Mar 1959 (CF), R. Hoffmann 15 Mar 1930 (CAS, SBM).

Salix lasiandra Benth. Yellow Willow. Tree; uncommon/scattered?; mouth of creek; Palustrine Forested Wetland; Carpinteria Creek; H. Pollard 7 Mar 1959 (CAS, SBBG).

Salix lasiolepis Benth. Arroyo Willow. Fig. 70. Shrub or tree; occasional/scattered to abundant; margin of marsh along railroad; berms, alluvial fans, ditches; Disturbed Coastal Habitat, Palustrine Emergent, Scrub/Shrub and Forested Wetlands; Carpinteria Salt Marsh and Creek; 1768, 1808, 2523, J. Patman 1151 (SBBG).

Salix sessilifolia Nutt. [S. hindsiana Benth. var. leucodendroides (Rowlee) Ball]. Valley Willow. Shrub or small tree; locally extirpated?; railroad and stream embankments; Disturbed Coastal Habitat, Palustrine Scrub/Shrub Wetland; Carpinteria Creek; H. Pollard 7 Mar 1959 (CF).

SAURURACEAE Lizard-Tail Family

Anemopsis californica (Nutt.) Hook. and Arn. Yerba Mansa. Fig. 71. Stoloniferous perennial herb; uncommon/abundant; high marsh, transitional wetland, seeps; Irregular Flooded Estuarine Emergent Wetland, Seasonally Flooded or Saturated Palustrine Emergent Wetland; west end of Carpinteria Salt Marsh at Sand Point Rd.; 1730, 1859, H. and M. Dearing 2781 (SBBG), J. Patman 1145 (SBBG).

SCROPHULARIACEAE Figwort Family

Cordylanthus maritimus Nutt. ex Benth. in DC. ssp. maritimus. Salt Marsh Bird's-Beak. Fig. 72. Annual; uncommon/scattered to abundant; sandbars in marsh, high marsh, banks of berms; Irregularly Flooded Estuarine Emergent Wetland; along Sand Point Rd. and rarely along Apple Rd.; 1736, 1945, 2068, H. Pollard 21 Sep 1956 (DS, UC, RSA), R. Hoffmann 13 Aug 1927 (SBM), A. Grant 1669 (POM), H. and M. Dearing 1760 (SBBG), J. Patman 1148 (SBBG).

Kickxia elatine (L.) Dumort. Sharp-Leaved Fluellin. Prostrate perennial herb; rare/rare; roadsides; Disturbed Coastal Habitat; naturalized; 1597.

Mimulus cardinalis Dougl. Scarlet Monkey-Flower. Perennial herb; locally extirpated?; mouth of Carpinteria Creek; H. Pollard 4 Sep 1958 (CF).

Scrophularia californica Cham. and Schlecht. ssp. californica. California Figwort. Perennial herb; occasional/scattered; berms, dredge spoil; Disturbed Coastal Habitat, Coastal Scrub; 1864.

Veronica anagallis-aquatica L. Great Water Speedwell. Perennial; uncommon/scattered; streambeds and banks; Palustrine and Riverine Emergent Wetlands; Carpinteria Creek; naturalized; 2412.

SOLANACEAE Nightshade Family

Datura meteloides DC. Toloache, Jimsonweed. Perennial herb; rare/rare; Disturbed Coastal Habitat; Meyers (1974).

Nicotiana glauca Graham. Tree Tobacco. Shrub or small tree; occasional/scattered; berms, alluvial fans, roadsides; Disturbed Coastal Habitats, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1819.

Solanum douglasii Dunal. Douglas' Nightshade. Suffrutescent perennial; occasional/scattered; berms, alluvial fans; Disturbed Coastal Habitat, Coastal Scrub; J. Patman 1124 (SBBG).

Solanum nigrum L. Black Nightshade. Annual; uncommon/scattered; margin of marsh along railroad; Palustrine Forested Wetland; naturalized; 2142, 2261.

Solanum nodiflorum Jacq. Small-Flowered Nightshade. Annual; occasional/scattered; bank of ditch along railroad; roadsides; Disturbed Coastal Habitat; Seasonally Flooded Palustrine Emergent Wetland; naturalized; 1810, 2138, 2514, H. Pollard 20 Aug 1965 (CAS, SBBG).

Solanum xantii Gray var. xantii. Purple Nightshade. Shrub; occasional/scattered; berms; Disturbed Coastal Habitat, Coastal Scrub; 2545b.

TROPAEOLACEAE Tropaeolum Family

Tropaeolum majus L. Garden Nasturtium. Annual or perennial; uncommon/abundant; debris piles, railroad banks, ditches; Disturbed Coastal Habitat, Palustrine Emergent Wetland; naturalized or introduced and persistent; 1779b.

URTICACEAE Nettle Family

Urtica dioica L. ssp. gracilis (Ait.) Seland var. holosericea (Nutt.) C. L. Hitchc. [U. holosericea Nutt.]. Hoary Nettle. Perennial; uncommon/scattered; ditches, banks; Palustrine Emergent Wetland; no collection.

Urtica urens L. Dwarf Nettle. Annual; occasional/scattered; berms; Disturbed Coastal Habitat; naturalized; 2753.

VERBENACEAE Vervain Family

Verbena lasiostachys Link. Western Verbena. Perennial herb; occasional/scattered; berms, dredge spoil, alluvial fans; Disturbed Coastal Habitats; 1861.

SUBCLASS MONOCOTYLEDONEAE

AMARYLLIDACEAE Amaryllis Family

Amaryllis belladonna L. Naked Lady. Bulbous perennial herb; rare/rare; debris pile adjacent to railroad; Disturbed Coastal Habitat; introduced and persistent; no collection.

CYPERACEAE Sedge Family

Carex praegracilis W. Boott. Perennial herb; locally extirpated?; sandy border of marsh; Irregularly Flooded Estuarine Emergent Wetland, Stabilized Dune; R. Hoffmann 20 Apr 1931 (SBM).

Cyperus esculentus L. Yellow Nut Grass. Perennial herb; uncommon/scattered; roadsides, ditches; Disturbed Coastal Habitat, Palustrine Emergent Wetland; naturalized; H. Pollard 6 Sep 1952 (CAS), 8 Aug 1961 (SBBG).

Cyperus alternifolius L. Umbrella Plant. Perennial herb; rare to occasional/rare to scattered; margin of marsh, ditches, streambeds; Irregularly Flooded Estuarine and Seasonally or Permanently Flooded Palustrine Wetlands; naturalized; Carpinteria Salt Marsh and Creek; 1854, 2414.

Cyperus eragrostis Lam. Umbrella Sedge. Perennial herb; occasional/scattered; alluvial fans, ditches; Disturbed Coastal Habitat, Seasonally or Permanently Flooded or Saturated Palustrine Emergent Wetlands; 1606, 2266.

Eleocharis montevidensis Kunth. Spike-Rush. Rhizomatous perennial herb; locally extirpated?; mouth of Carpinteria Creek; Palustrine Emergent Wetland; H. Pollard 19 Jul 1957 and 26 Aug 1958 (CAS).

Scirpus americanus Pers. [S. olneyi Gray]. Winged Three-Square. Rhizomatous perennial herb; locally extirpated?; mouth of Carpinteria Creek and seep east of creek; Estuarine and Palustrine Emergent Wetlands; 2408, H. Pollard 21 Aug 1955 (CAS) and 31 Aug 1961 (SBBG).

Scirpus californicus (C. A. Mey.) Steudel. California Bulrush. Fig. 73. Rhizomatous perennial herb; occasional/common to abundant; brackish marsh, ditch along railroad; Irregularly Flooded Estuarine and Permanently or Seasonally Flooded Palustrine Emergent Wetlands; 1959, 2145.

Scirpus maritimus L. [S. paludosus A. Nels.]. Prairie Bulrush. Fig. 74. Tuberous perennial herb; occasional to common/scattered to abundant; low marsh, middle marsh, tidal and nontidal ditches; Irregularly Exposed and Irregularly Flooded Estuarine Emergent Wetland, Permanently and Seasonally Flooded Palustrine Emergent Wetlands; Carpinteria Salt Marsh and Creek; 1720, 1960, H. Pollard 21 Sep 1957 (CAS), 19 July 1957 (SBBG), J. Patman 1147 (SBBG).

Scirpus microcarpus Presl. Small-Fruited Bulrush. Rhizomatous perennial herb; uncommon/common; ditch along railroad and mouth of Carpinteria Creek; Permanently and Seasonally Flooded Palustrine Emergent Wetland; Carpinteria Salt Marsh and Creek; 2140, 2159, H. Pollard 19 Jul 1957 (CF).

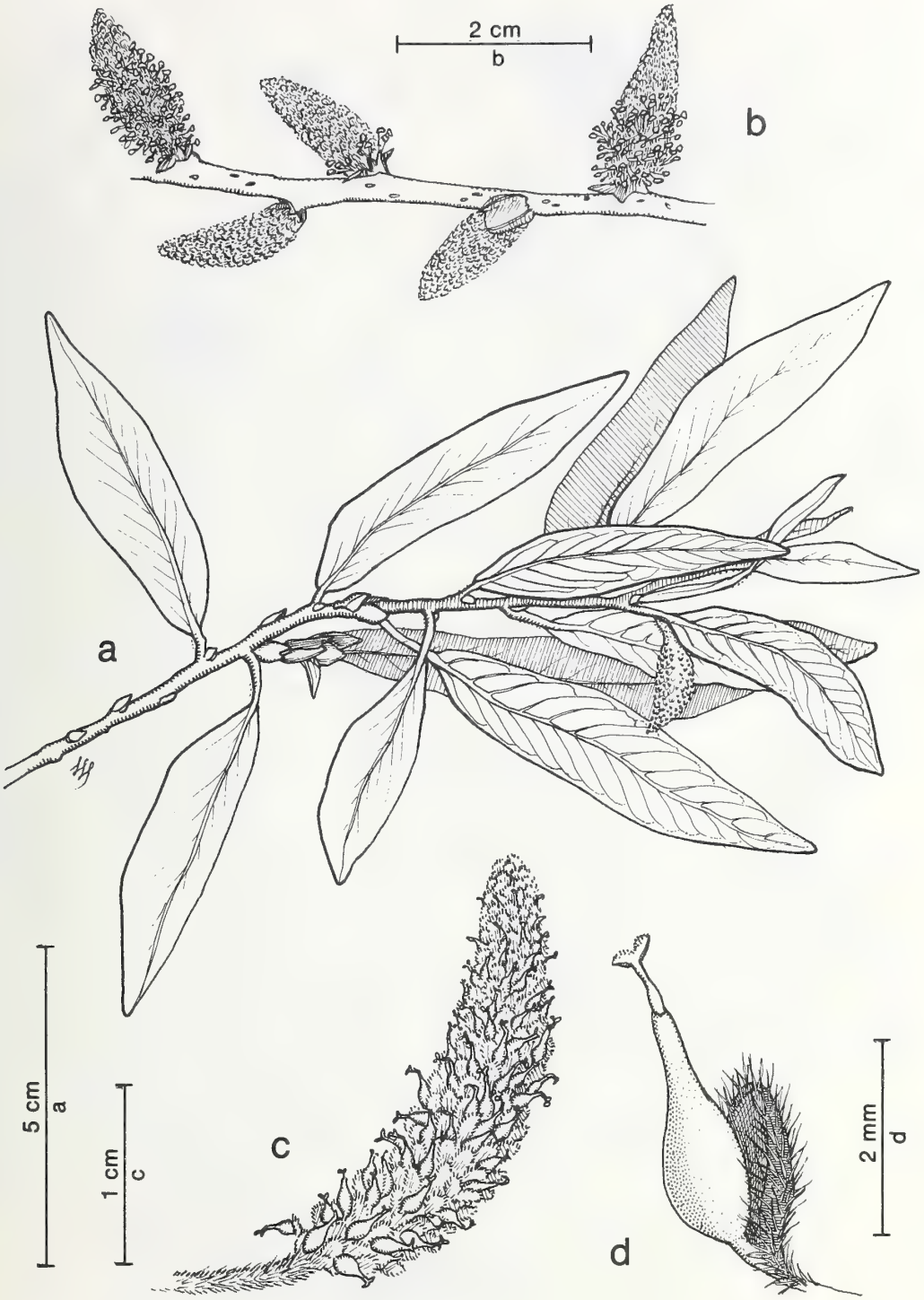


FIG. 70. *Salix lasiolepis* Benth. Arroyo Willow.
a. Branch. b. Male catkins. c. Female catkin. d. Female flower.



FIG. 71. *Anemopsis californica* (Nutt.) Hook. and Arn. Yerba Manza. a. Habit. b. Inflorescence and stem.

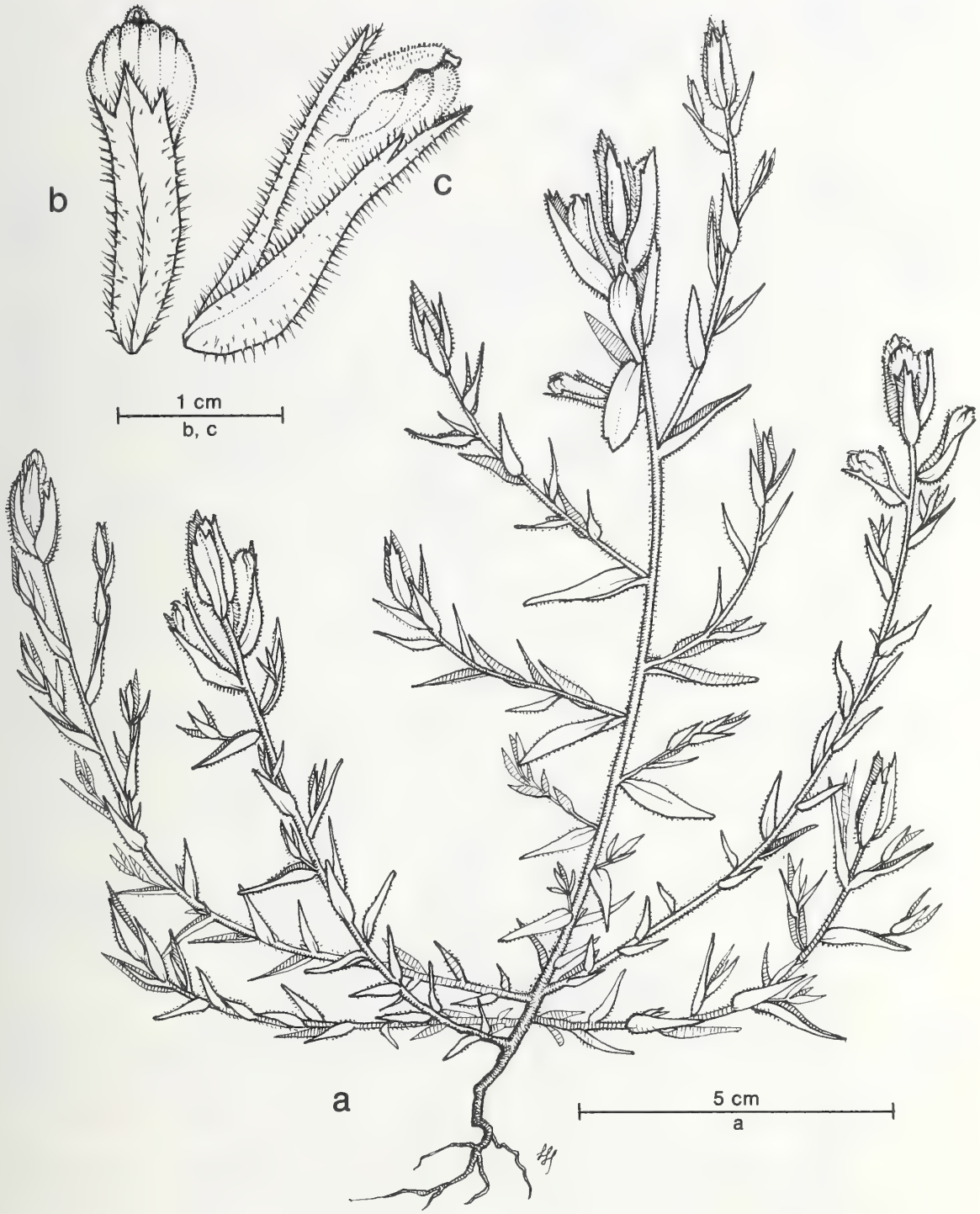


FIG. 72. *Cordylanthus maritimus* Nutt. ex Benth. in DC. ssp. *maritimus*. Salt Marsh Bird's-Beak. a. Habit. b. Flower, abaxial view. c. Flower, lateral view.

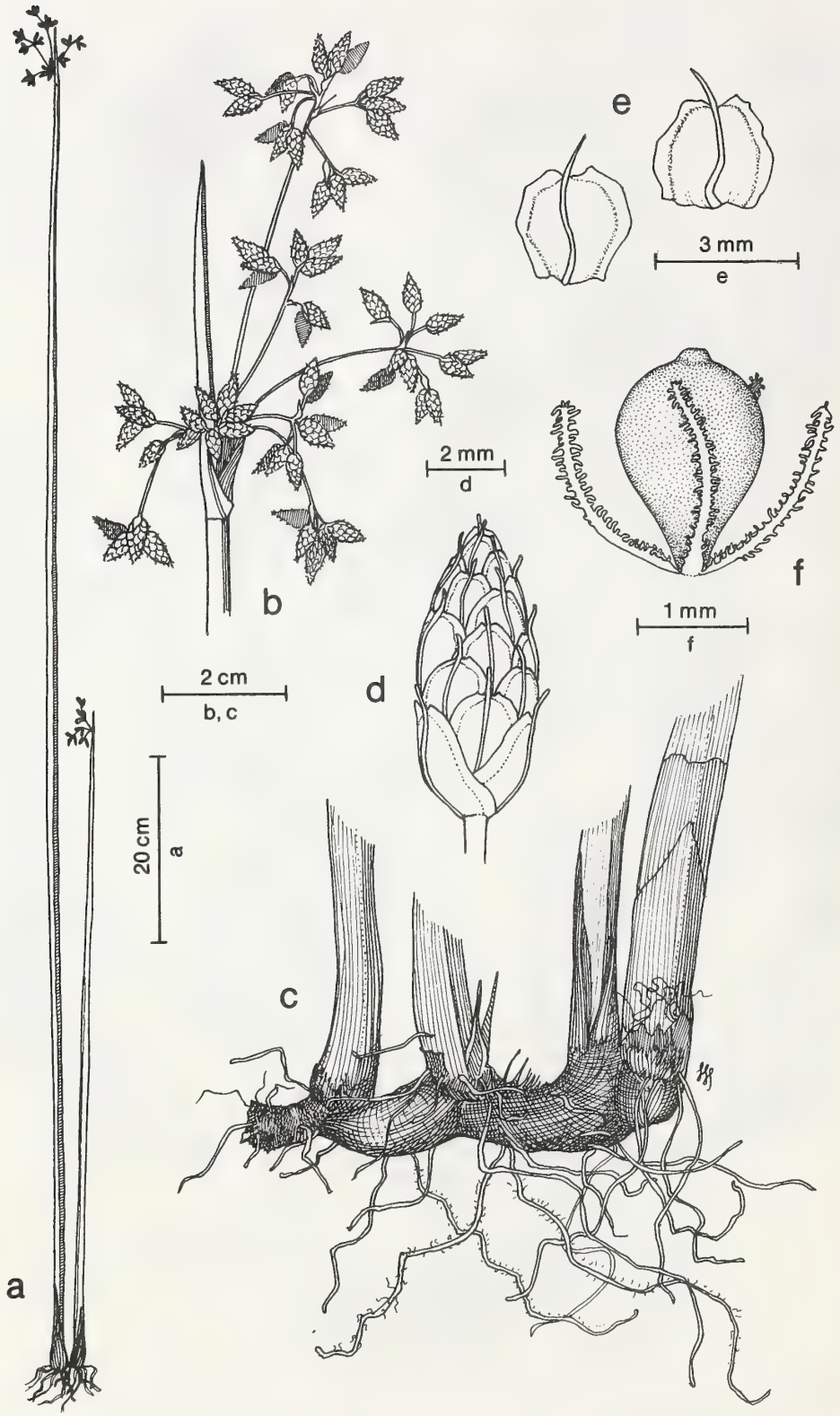


FIG. 73. *Scirpus californicus* (C. A. Mey.) Steudel. California Bulrush. a. Habit. b. Inflorescence with numerous spikelets. c. Rhizome and bases of shoots. d. Spikelet. e. Scales. f. Achene with bristles.

Scirpus pungens Vahl. [S. americanus auct., non Pers.]. Three-Square. Rhizomatous perennial herb; locally extirpated?; Carpinteria Creek and behind dunes at Carpinteria Beach; Estuarine and Palustrine Emergent Wetland; 2407, H. Pollard 29 Jul 1957 (CAS), R. Hoffmann 4 Sep 1930 (SBM), C. Smith 2283 (SBBG).

JUNCACEAE Rush Family

Juncus acutus L. var. sphaerocarpus Engelm. Spiny Rush. Caespitose perennial herb; locally extirpated; behind dunes and near railroad yard; Stabilized Dune, Estuarine and Palustrine Emergent Wetlands; F. Coville (?) ca. 1895 (SBM), H. Pollard 20 Jun 1958 (CAS), C. Smith 1720 (SBBG).

Juncus bufonius L. Common Toad Rush. Fig. 75. Annual; occasional to common/scattered to abundant; berms, dredge spoil, alluvial fans, high marsh, transitional wetlands, ditches along railroad; Disturbed Coastal Habitats, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; 2389, 2390, 2403.

Juncus patens E. Mey. Spreading Rush. Fig. 76. Caespitose perennial herb; uncommon/scattered; margin of marsh along railroad; Palustrine Forested Wetland; J. Patman 1146 (SBBG).

Juncus rugulosus Engelm. Wrinkled Rush. Rhizomatous perennial; uncommon/locally extirpated?; marsh above mouth of Carpinteria Creek; H. Pollard 29 Jul 1957 (CAS), 4 Sep 1958 (CF).

Juncus textilis Buch. Basket Rush. Rhizomatous perennial; uncommon/common to abundant; seep at northwestern margin of estuary and mouth of creek; Palustrine Emergent Wetland; Carpinteria Salt Marsh and Creek; 1778, 2406, 2415, H. Pollard 19 Jul 1957 (CAS, RSA) 26 Aug 1958 (CAS), R. Beeks 22 Oct 1951, R. Hoffmann 13 Aug 1927 (SBM).

Juncus xiphioides E. Mey. Iris-Leaved Rush. Rhizomatous perennial herb; uncommon/scattered?; marsh at mouth of Carpinteria Creek; Palustrine Emergent Wetland; H. Pollard 31 Aug 1952 (CAS), 17 Jul 1959 (SBBG).

JUNCAGINACEAE Arrow-Grass Family

Triglochin concinna Burtt-Davy. Seaside Arrow-Grass. Fig. 77. Rhizomatous perennial herb; rare/scattered to abundant; middle to upper marsh; Irregularly Flooded Estuarine Emergent Wetland; western end of estuary and east of Apple Rd.; 1735, 2077, R. Hoffmann 13 Aug 1927 (SBM).

Triglochin striata Ruiz and Pavon. Three-Ribbed Arrow-Grass. Rhizomatous perennial herb; locally extirpated?; marsh at mouth of Carpinteria Creek; H. Pollard 5 Sep 1957 (CAS, UC).

LEMNACEAE Duckweed Family

Lemna gibba L. Gibbous Duckweed. Floating annual; locally extirpated?; stagnant pools on Franklin Creek at railroad; Palustrine and Riverine Wetland; H. Pollard 21 Oct 1958 (CAS).

Lemna minor L. Lesser Duckweed. Floating annual; occasional/scattered to abundant; ditches along railroad and stagnant pools on Franklin Creek at railroad; Palustrine and Riverine Wetland; 2264, H. Pollard 21 Oct 1958 (CAS).

LILIACEAE Lily Family

Asparagus officinalis L. Asparagus. Perennial herb; uncommon/scattered; ditch along railroad; Seasonally Flooded Emergent Wetland; naturalized; 2513.

Yucca gloriosa L. Spanish Dagger. Evergreen shrub; rare/rare; debris pile; Disturbed Coastal Habitat; introduced and persistent; 2317.

POACEAE Grass Family

Agrostis semiverticillata (Forsk.) C. Christens. Water Bent. Stoloniferous perennial; occasional/scattered; ditches, transitional wetland; Irregularly Flooded Estuarine Emergent Wetland; Seasonally Flooded Palustrine Emergent Wetland; naturalized; 1601.

Agrostis stolonifera L. var. major (Gaud.) Farwell. Redtop. Stoloniferous perennial; uncommon/scattered?; roadside behind beach; Disturbed Coastal Habitat; naturalized; H. Pollard 20 Aug 1965 (SBBG).

Arundo donax L. var. donax. Giant Reed. Stout perennial; uncommon/common to abundant; debris piles, alluvial fans; Disturbed Coastal Habitat; introduced and persisent; 1811.

Arundo donax L. var. versicolor (P. Mills) Stokes. Striped Giant Reed. Stout perennial; uncommon/abundant; margin of marsh along railroad, transitional wetland; Palustrine Emergent Wetland, Disturbed Coastal Habitat?; introduced and persistent?; 1949, H. Pollard 24 Nov 1958 (CAS, SBBG).

Avena fatua L. Wild Oat. Annual; occasional to common/scattered to common; berms, dredging spoil, alluvial fans, roadsides, transitional or temporary wetlands; Disturbed Coastal Habitat, Grassland, Irregularly Flooded Estuarine and Seasonally or Temporarily Flooded Palustrine Wetlands; naturalized; 1797, 1968, 2190a.

Bromus carinatus Hook. & Arn. var. carinatus. California Brome. Perennial; rare/uncommon; edge of marsh; Grassland?; R. Hoffmann 30 May 1925 (SBM).

Bromus diandrus Roth. Ripgut Grass. Annual; occasional/scattered to abundant; berms, dredge spoil, roadsides, debris piles, alluvial fans, transitional or vernal wetlands; Disturbed Coastal Habitat, Grassland, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1772, 1792, 1816, 2185.

Bromus hordeaceus L. ssp. hordeaceus (B. mollis L.) [probably including material of B. h. ssp. molliformis (Lloyd) Maire and Weiller in Maire]. Soft Chess. Annual; occasional/scattered to common; berms, dredge

spoil, roadsides, alluvial fans, transitional or vernal wetlands; Disturbed Coastal Habitat, Grassland, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1762, 2187.

Bromus rubens L. Foxtail Chess. Annual; occasional/scattered to common; berms, dredge spoil, transitional or vernal wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1828, 2185.

Bromus willdenowii Kunth. Rescue Grass. Annual or biennial; uncommon/scattered to abundant; berms, roadsides, vernal wetlands; Disturbed Coastal Habitat, Seasonally Flooded or Saturated Palustrine Emergent Wetland; naturalized; 1938, 2186.

Chloris gayana Kunth. Rhodes Grass. Stoloniferous perennial; rare/common?; along railroad at Franklin Creek; Disturbed Coastal Habitat; naturalized; H. Pollard 21 Aug 1958 and 24 Nov 1958 (SBBG).

Cynodon dactylon. Bermudagrass. Creeping rhizomatous perennial; uncommon/abundant; roadsides, railroad banks, debris piles; Disturbed Coastal Habitats; naturalized; 1978.

Distichlis spicata (L.) Greene var. spicata. Saltgrass. Fig. 77. Rhizomatous perennial; common/common to abundant; berms, roadsides, dunes, middle and upper marshes, diked marshes, transitional and seasonal wetlands; Disturbed Coastal Habitat, Stabilized Dune, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; 1976, C. Smith 2488 (SBBG), J. Patman 1140 (SBBG).

Echinochloa crusgalli (L.) Beauv. var. oryzicola (Vasing) Ohwi. Barnyard Grass. Annual; occasional/scattered to common; ditches along railroad; Permanently and Seasonally Flooded and Saturated Palustrine Emergent Wetlands; naturalized; 1723, 2073, M. Piehl 62435 (SBBG).

Elymus condensatus Presl. Giant Rye-Grass. Stout rhizomatous perennial; occasional/scattered; berms, dredge spoil, roadsides, alluvial fans; Disturbed Coastal Habitat, Grassland, Coastal Scrub; 1614, 1813, 1970, 2322.

Eragrostis barrelieri Daveau. Annual; uncommon/?; low waste ground at mouth of Carpinteria Creek; Disturbed Coastal Habitat or Emergent Wetland?; naturalized; H. Pollard 4 Sep 1958 (CAS).

Eragrostis orcuttiana Vasey. Orcutt's Eragrostis. Annual; locally extirpated?; low ground at mouth of Carpinteria Creek; Disturbed Coastal Habitat or Emergent Wetland?; H. Pollard 4 Sep 1958, 26 Aug 1958, 4 Sep 1958 (CF).

Eragrostis pectinacea (Michx.) Nees. [E. diffusa Buckl.]. Annual; uncommon/?; low waste ground at mouth of Carpinteria Creek; Disturbed Coastal Habitat or Emergent Wetland?; naturalized?; H. Pollard 4 Sep 1958 (CAS).

Hordeum depressum (Scribn. & Sm.) Rydb. Alkali Barley. Fig. 78. Annual; uncommon/scattered to common; berms, alluvial fans, high marsh, vernal wetlands; Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; Apple Rd. and alluvial fan west of Santa Monica Creek; 2547, 2548, 2637.

Hordeum geniculatum All. Mediterranean Barley. Fig. 79. Annual; common/common to abundant; berms, dredge spoil, transitional and vernal wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1616, 1867, 1981, 2196, R. Hoffmann 30 May 1925 (SBM).

Hordeum murinum L. ssp. leporinum (Link) Arcangeli. [H. leporinum Link]. Wild Barley. Fig. 79. Annual; occasional/scattered to common; berms, dredge spoil, transitional wetland; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1866, 1980, 2190b, 2398, 2546.

Leptochloa fascicularis (Lam.) Gray. [Diplachne fascicularis (Lam.) Beauv.]. Bearded Spangletop or Clustered Salt-Grass. Annual; uncommon/scattered; ditches; Palustrine Emergent Wetland; naturalized?; 1596.

Lolium multiflorum Lam. [Lolium perenne L. ssp. multiflorum (Lam.) Husnot]. Italian Ryegrass. Annual or perennial; occasional to common/common to abundant; berms, dredge spoil, roadsides, alluvial fans, transitional or vernal wetlands. Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1807, 2188, R. Hoffmann 30 May 1925 (SBM).

Monanthochloe littoralis Engelm. Shoregrass. Fig. 80. Stoloniferous perennial; occasional/common to abundant; berms, alluvial fans, sandbars in marsh, high marsh; Irregularly Flooded Estuarine Emergent Wetland; Apple Rd., alluvial fan west of Santa Monica Creek, sandbar north of Sand Point Rd.; 1583, 1737, 1944, 2387, H. Pollard 9 Aug 1962 (SBBG), J. Patman 1164 (SBBG), H. Wilson 15 Oct 1949 (SBBG).

Oryzopsis miliacea (L.) Benth. & Hook. ex Aschers. and Graebn. [Piptathesum miliaceum (L.) Cosson.]. Rice Grass. Caespitose perennial herb; occasional/scattered; berms, dredge spoil, roadsides, alluvial fans; Disturbed Coastal Habitat, Grassland; naturalized; 1834, 2075.

Parapholis incurva (L.) C. E. Hubb. Sicklegrass. Fig. 80. Annual; common/common to abundant; berms, alluvial fans, salt flats, high marsh, diked marshes, transitional and vernal wetlands. Disturbed Coastal Habitat, Irregularly Flooded Estuarine and Seasonally Flooded Palustrine Emergent Wetlands; naturalized; 1836, 1853, 2386.

Paspalum dilatatum Poir. Dallis Grass. Caespitose perennial; occasional/scattered; margins of ditches along railroad; Permanently or Seasonally Flooded and Saturated Palustrine Emergent Wetlands; naturalized; 1955, 2137.

Pennisetum clandestinum Hochst. ex Chiov. Kikuyu Grass. Stoloniferus perennial; occasional/common to abundant; berms, roadsides, railroad

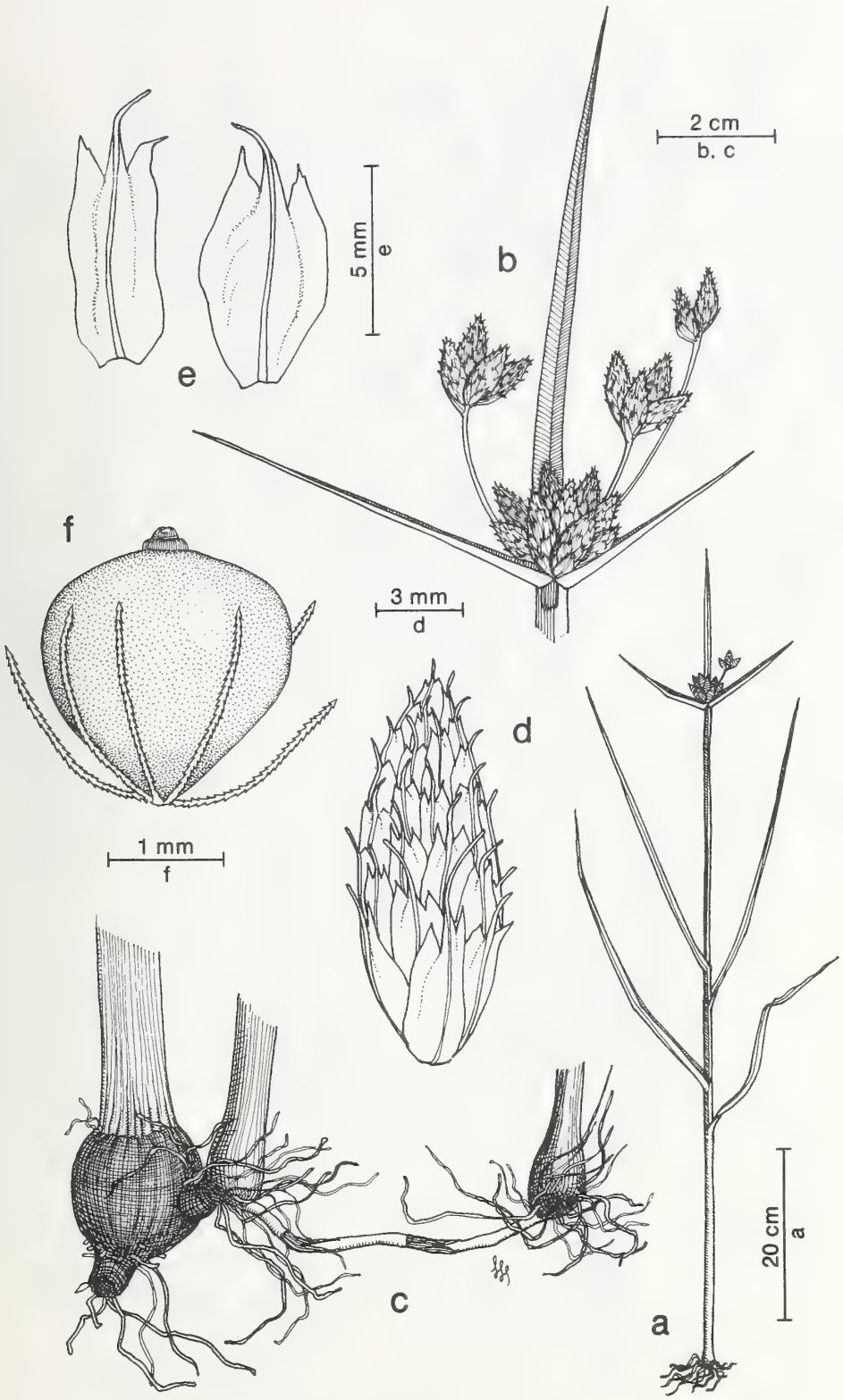


FIG. 74. *Scirpus maritimus* L. Prairie Bulrush.
a. Habit. b. Inflorescence. c. Tuberous rhizome and bases of shoots. d. Spikelet.
e. Scales. f. Achene with bristles.

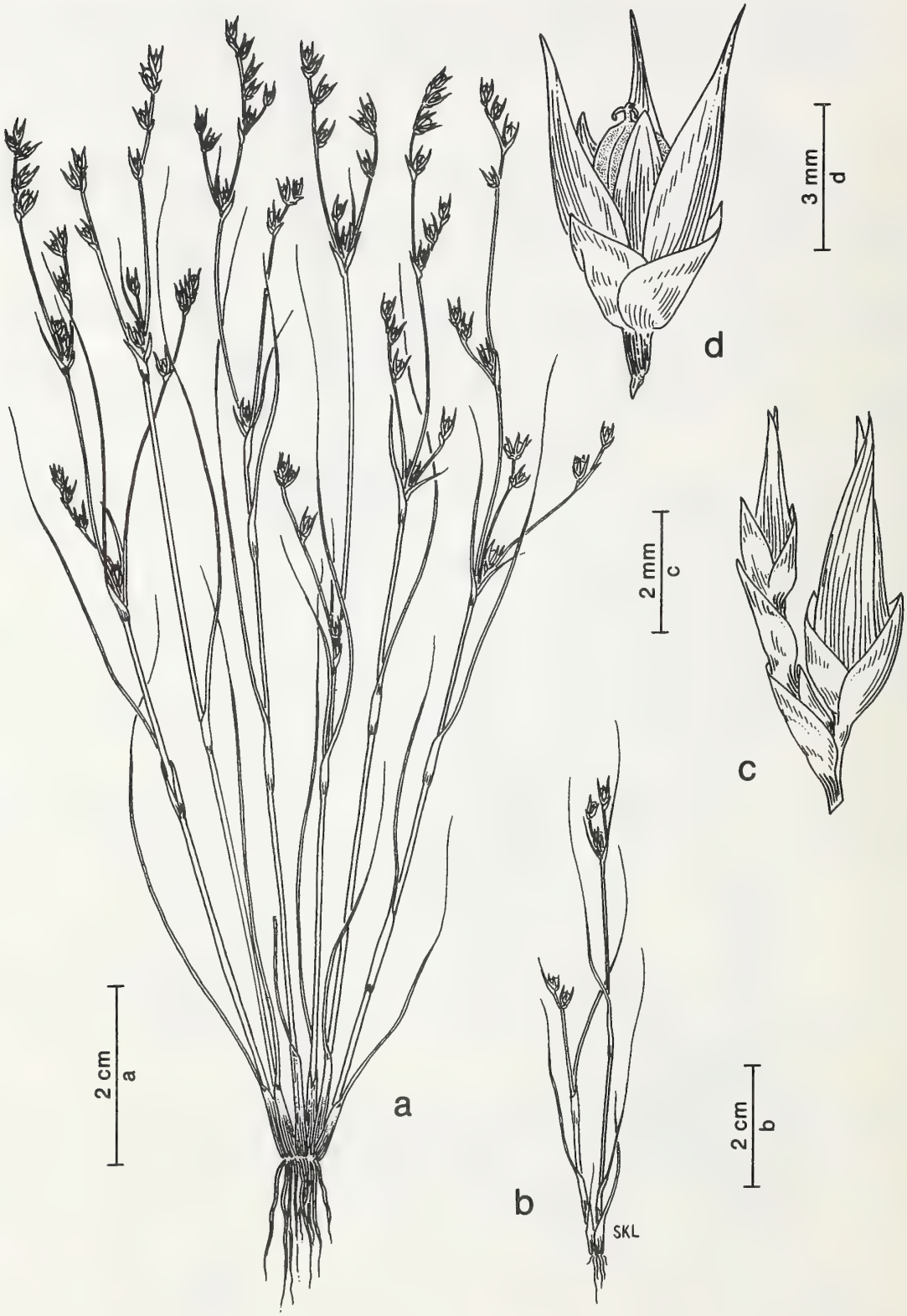


FIG. 75. *Juncus bufonius* L. Common Toad Rush.
a, b. Habit. c. Flowers, in bud. c. Flower with bracts, tepals, fruit (capsule).

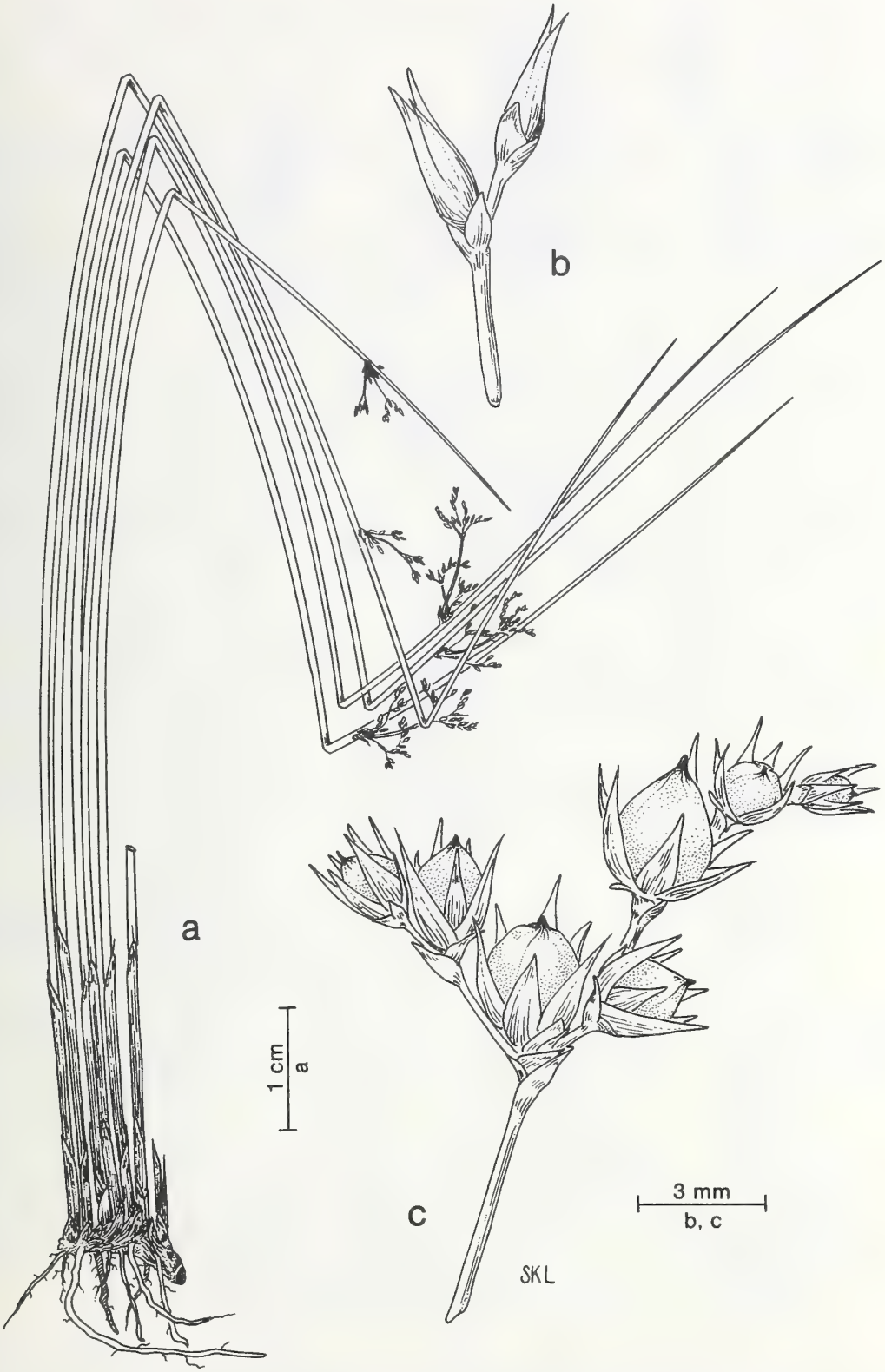


FIG. 76. *Juncus patens* E. Mey. Spreading Rush.
a. Habit. b. Flowers, in bud. c. Capsules and inflorescence.

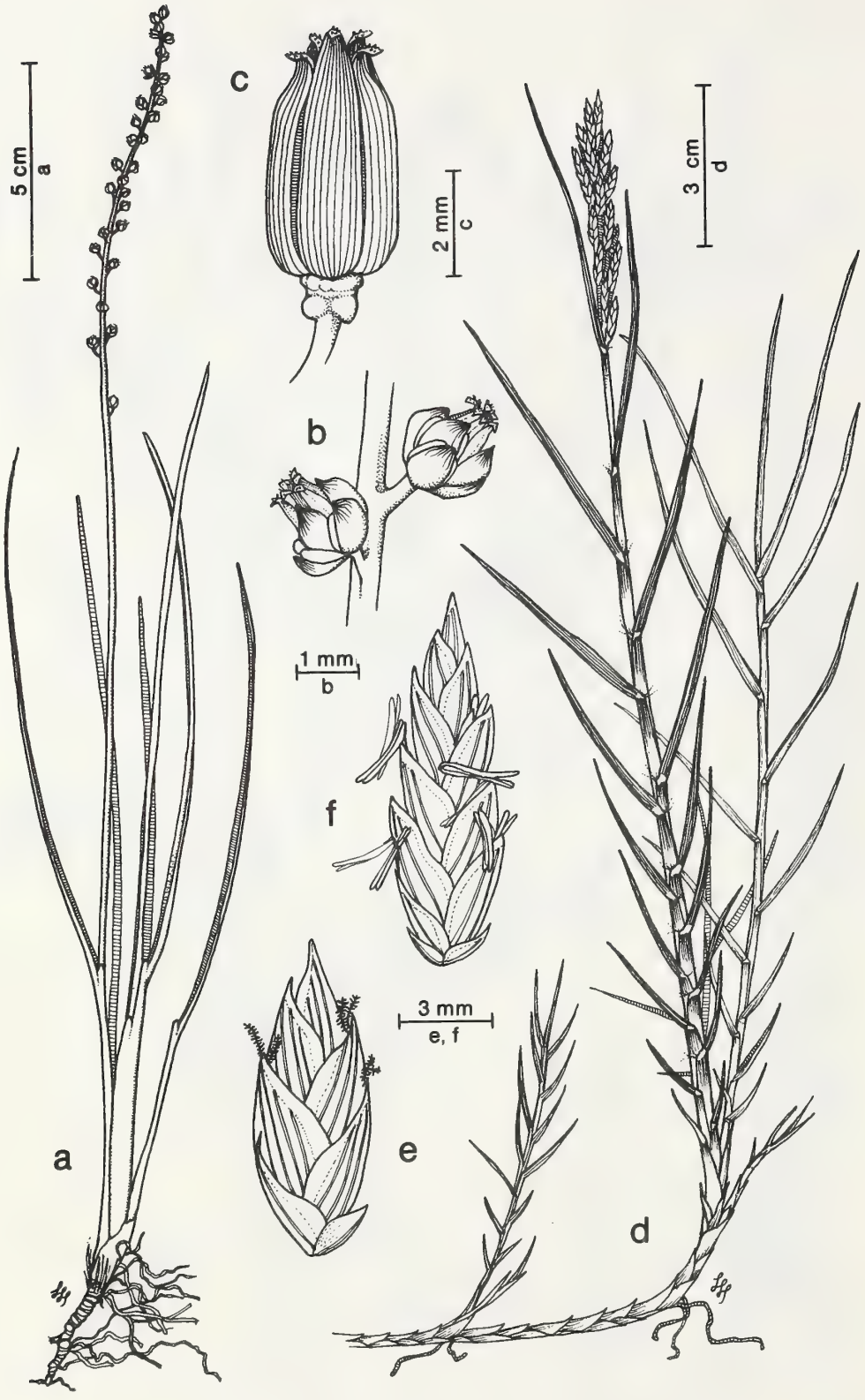


FIG. 77. *Triglochin concinna* Burtt-Davy. Seaside Arrowgrass.
a. Habit. b. Flowers. c. Capsule. *Distichlis spicata* (L.) Greene. var. *spicata.* Saltgrass. d. Habit, male plant. e. Spikelet with pistillate florets. f. Spikelet with staminate florets.

banks, debris piles, alluvial fans; Disturbed Coastal Habitat, Seasonally Flooded Palustrine Emergent Wetlands; naturalized; M. Piehl 62438 (SBBG).

Pennisetum villosum R. Br. ex. Fresen. Feathertop. Caespitose perennial; uncommon/scattered; railroad banks; Disturbed Coastal Habitat; naturalized; 1603, 2074.

Poa annua L. Wintergrass. Tufted annual; occasional/scattered; margins of ditches along railroad; Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1783.

Polypogon interruptus H.B.K. Beard Grass. Caespitose perennial; occasional/scattered; berm slopes, ditches along railroad; Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetlands; naturalized; 1857.

Polypogon monspeliensis (L.) Desf. Rabbitsfoot Grass. Annual herb; occasional/scattered to common; berm slopes, brackish marsh, ditches along railroad; Irregularly Flooded Estuarine and Seasonally Flooded or Saturated Palustrine Emergent Wetland; naturalized; 1852, 1961, J. Patman 1119, 1161 (SBBG).

Setaria geniculata (Lam.) Beauv. Perennial Foxtail. Caespitose perennial; uncommon/?; waste ground at mouth of Carpinteria Creek; Disturbed Coastal Habitat?; naturalized; H. Pollard 17 Jul 1959 (SBBG).

Setaria pumila (Poir.) Schultes. [S. lutescens (Wiegel) F. T. Hubbard]. Yellow Foxtail. Annual; uncommon/?; weedy area at mouth of Carpinteria Creek; Disturbed Coastal Habitat?; naturalized; H. Pollard 4 Sep 1958 (CF).

Sorghum bicolor (L.) Moench ssp. bicolor. Sorghum. Annual; uncommon/scattered; railroad banks and margins; Disturbed Coastal Habitat; naturalized; 1602, H. Pollard 9 Sep 1964 (CAS, SBBG).

Sorghum sudanense (Piper) Stapf. [S. bicolor (L.) Moench var. sudanense (Piper) A. S. Hitchc.]. Sudan Grass. Annual; uncommon/?; railroad banks and margins; Disturbed Coastal Habitat; naturalized; H. Pollard 8 Aug 1961 (CAS, SBBG).

Vulpia bromoides (L.) S. F. Gray. [Festuca dertonensis (All.) Aschers. & Graebn.]. Foxtail Fescue. Annual; occasional/common to abundant; berms, high marsh, transitional wetlands; Disturbed Coastal Habitat, Irregularly Flooded Estuarine Emergent Wetland; naturalized; 1801, 2198.

RUPPIACEAE Ditchgrass Family

Ruppia maritima L. Ditchgrass. Fig. 81. Rooted submerged annual; rare/abundant; vernal wetland in depression; Seasonally Flooded Palustrine Wetland and Permanently Flood Estuarine Emergent Wetland; south end of Apple Rd., mouth of Carpinteria Creek; 1615, 2799.

TYPHACEAE Cattail Family

Typha domingensis Pers. Narrowleaf Cattail. Stout rhizomatous perennial herb; occasional/common to abundant; high marsh, ditches along railroad; Irregularly Flooded Estuarine and Permanently or Seasonally Flooded Palustrine Emergent Wetlands; Carpinteria Salt Marsh and Creek; 1725, 2521, H. Pollard 15 Aug 1955 (CAS), 21 Aug 1955 (CAS).

Typha domingensis Pers. X T. latifolia L. [T. X glauca Godr.]. Hybrid Cattail. Stout rhizomatous perennial herb; occasional/common to abundant; ditches along railroad; Permanently and Seasonally Flooded Estuarine Emergent Wetland; 2520, H. Pollard 15 Aug 1955 (CF), 9 Aug 1968 (SBBG).

Typha latifolia L. Broadleaf Cattail. Stout rhizomatous perennial herb; occasional/common to abundant; ditches along railroad; Permanently and Seasonally Flooded Palustrine Emergent Wetland; 1722, 2522, H. Pollard 9 Aug 1968 (SBBG).

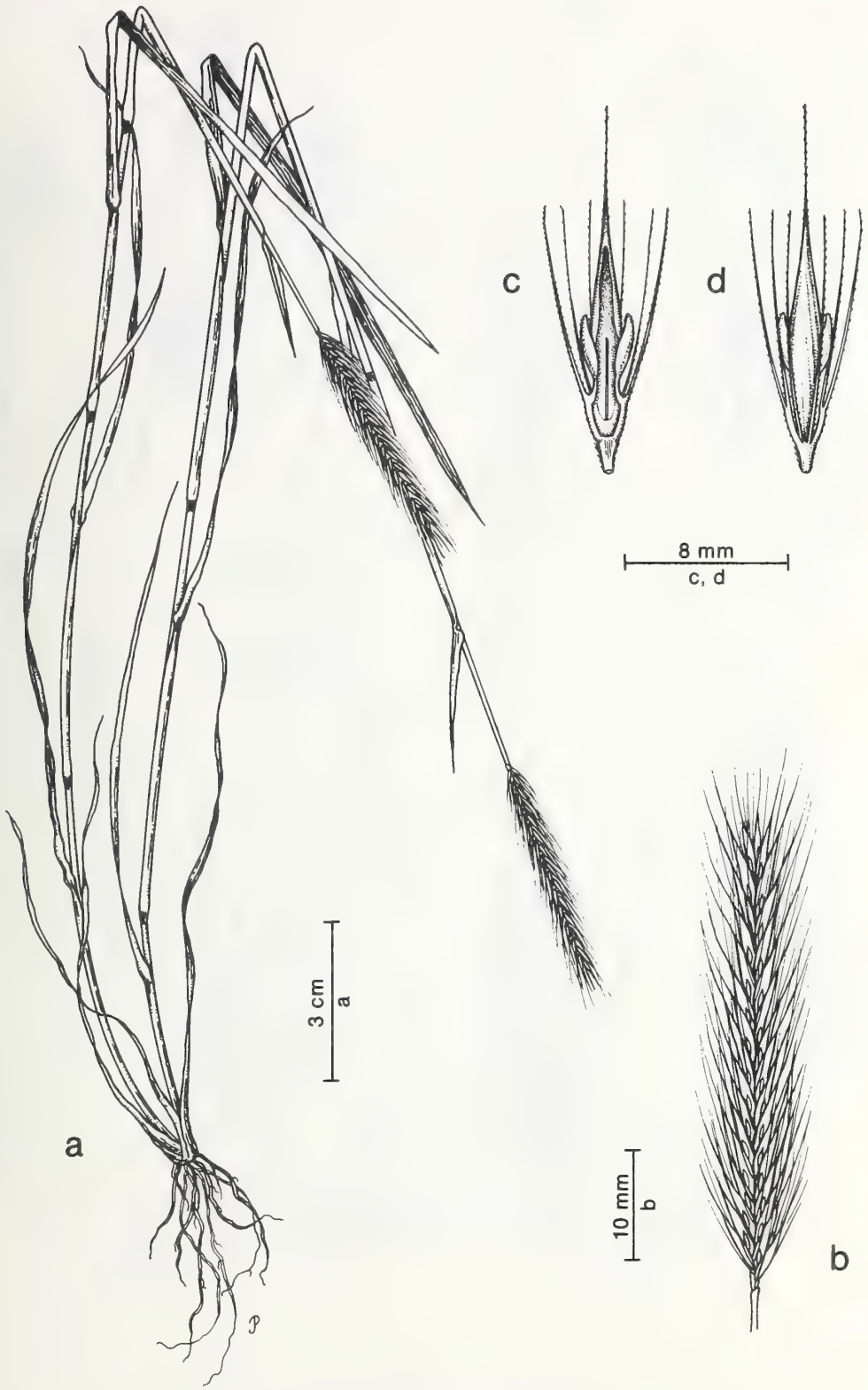


FIG. 78. *Hordeum depressum* (Scribn. and Sm.) Rydb. Alkali Barley.
a. Habit. b. Spike. c. Spikelets, three per node, adaxial view. d. Spikelets, abaxial view.

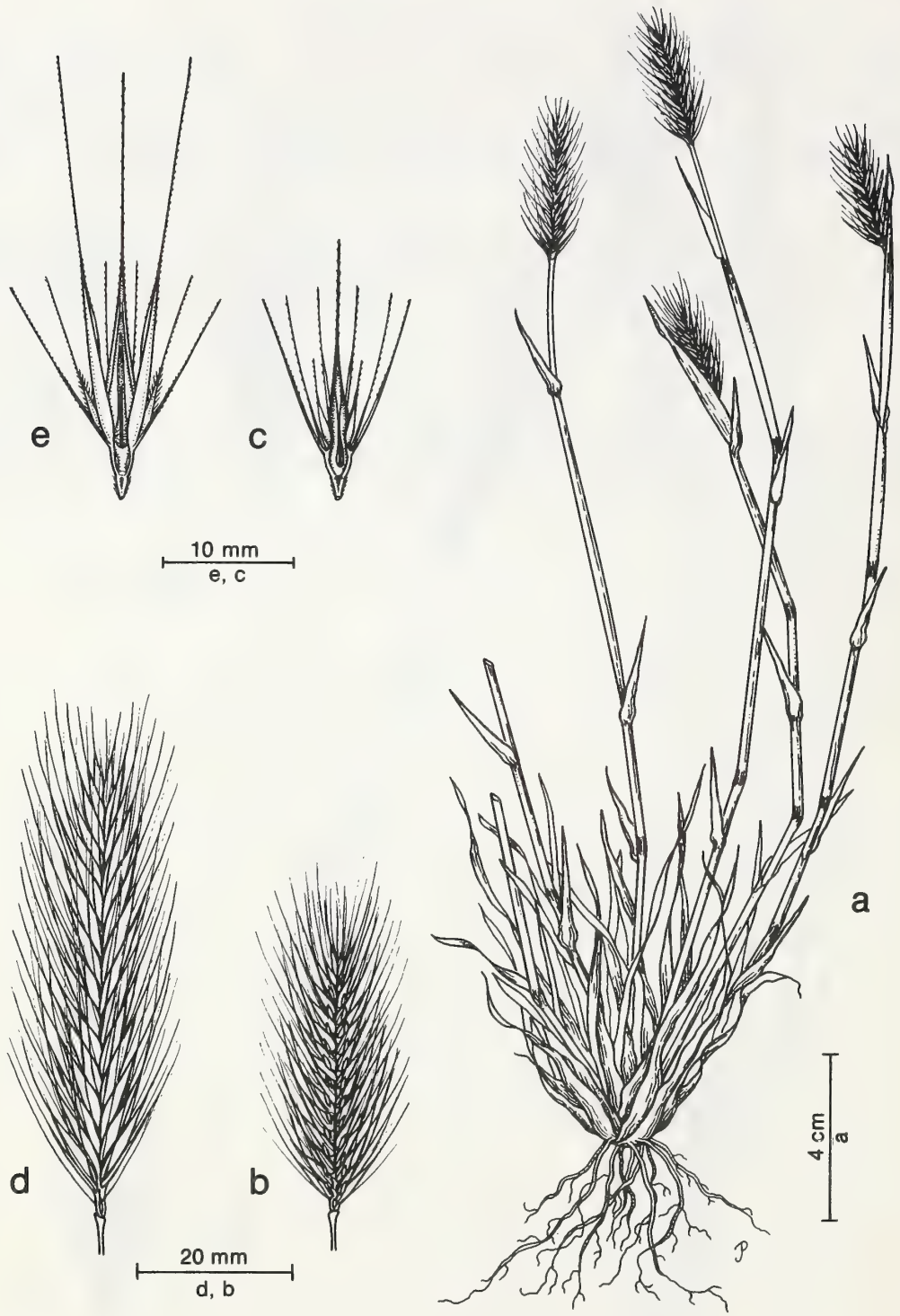


FIG. 79. *Hordeum geniculatum* All. Mediterranean Barley.
a. Habit. b. Spike. c. Spikelets, three per node, adaxial view. *Hordeum murinum* L. ssp. *leporinum* (Link) Arcangeli. Wild Barley. d. Spike. e. Spikelets, three per node, adaxial view.



FIG. 80. *Monanthochloe littoralis* Engelm. Shoregrass.
a. Habit, female plant. b. Spikelet with pistillate florets on leafy stem. c. Spikelet with staminate florets. *Parapholis incurva* (L.) C. E. Hubb. Sicklegrass. d. Habit. e. Spikelets embedded in rachis.

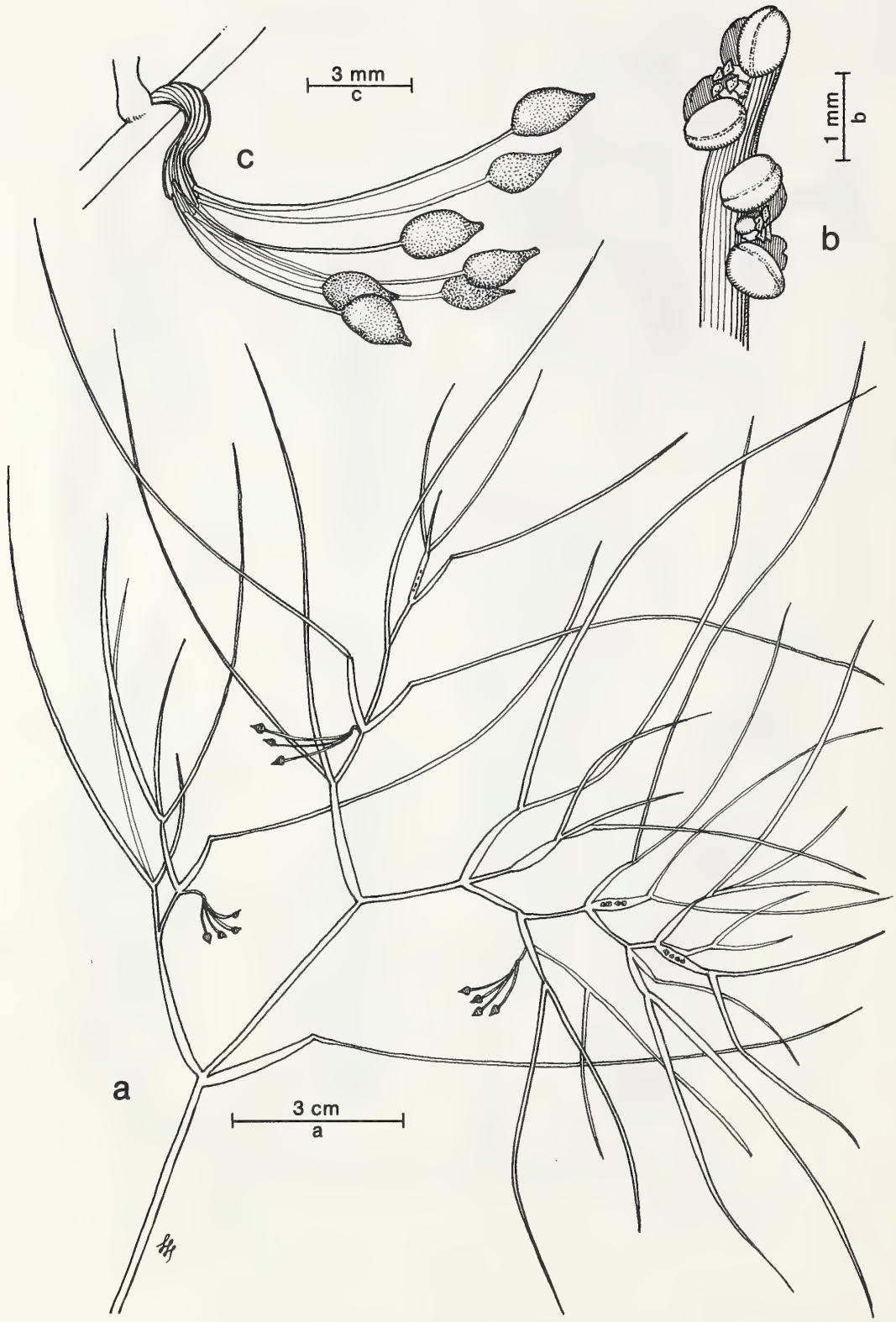


FIG. 81. *Ruppia maritima* L. Ditchgrass.
a. Habit. b. Flowers on spadix. c. Fruits (drupes) stalked.

Abronia umbellata.....259
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